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ABSTRACT

This document contains the 18 papers on health-related and medical care issues of the elderly that were presented at the 1981 White House Conference on Aging. The materials focus on the following topics: physical mobility, death, heart disease, nutrition, injury, senile dementia, post-menopausaul women, gerontological nursing, learning and memory, oral health, osteoporosis, pharmacology, physician/patient relationships, psychosocial factors, cancer research, high-risk patients, and sleep. A table of contents provides an alphabetical-by-title list of the papers along with appropriate references, tables, and/or figures at the conclusion of each paper. (NRB)

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WHITE CONFERENCE ON AGING, 1981:
Health-Related and Medical Care Issues of the Elderly
Eighteen Reports

Papers presented at the White House Conference on Aging, Washington, DC, November 30 - December 3, 1981.

CG 015991

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Biological Aspects of Falls and Mobility Limitations in the Elderly

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Introduction

The problem of distur[illegible]ity in the elderly and the associated falls and injuries cannot be treated comprehensively in this brief communication. The resultant bias will be neurological and some readers will be alarmed by my premeditated disregard of the connective tissues.

Normal motility in the human is a highly complex acquired function which requires intergration of neural activity at many levels within the nervous system; each more rostral level adding variety and nicety to the performance of the motor task. The normal infant is born with stepping reflexes, and placing reflexes but does not walk until the 11-14th month. Infants kept immobilized for orthopedic problems until this age, when freed of their impediment walk within a day or two. This suggests the that the 11-14th months are required more for anatomical maturational processes within the nervous system than for "motor learning". Several more years are required for motor tasks involved in the complex manipulations of writing, playing musical instruments or total body coordination feats demanded by certain athletic activities. In Alzheimer's disease - senile dementia there is a reversal of the patterns seen in development with the release of certain motor reflexes which are normal only in infancy.

An imagined stop action view of the gait halfway through a normal step helps us appreciate the complexity of the motor system. At this halfway point, the entire weight is on one foot. The other leg is off the ground because of flexion at the hip, knee and ankle combined with abduction in the weight-bearing hip. There is a very small range of movement in the lifted leg which is safe; beyond this range the body will be overbalanced and there will be a fall. Still thus poised; a precise sequence of motor acts must unfold to successfully complete the step. The torso must be tipped forward with simultaneous angular rotation at the weight-bearing hip. The lifted leg then causes a forward shift in the center of gravity causing the trunk to topple forward. This is halted by extension of the flexed lower extremity which occurs in such finely calibrated increments that both weight-bearing and shock absorber functions are achieved.[1] The painful shock radiating through the leg when the height of a step down is misjudged is an everyday life experience which dramatizes the precision of this movement.

The lower motor neurons, neuromuscular junction, the muscle contractile mechanism as well as suprasegmental influences from corticospinal and extrapyramidal - cerebellar motor systems all must function normally. Yet, none of these efferent systems can function without the rich afference of muscle spindles, tendon organs, tactile receptors, vestibular and visual input.[2]

Numerous identifiable and sometimes treatable diseases can affect these systems in the elderly and cause poor mobility. Yet the nearly ubiquitous gait deterioration in the aged does not seem to be part of another disease, nor has its pathological basis been discerned.

One need not dwell upon the implications of gait disorder to realize the telling impact on the elderly. There is a psychological and physical constriction of life activity. Bone fragility makes falls ever more dangerous. The fractured hip is an obvious and all too commonplace reminder of the consequence of falling for the aged. Epidemiologic studies reveal an incidence of 7 hip fractures per 10,000 of total population per year. The mean age of these patients is 69 for males and 73 for females.[3] The event is not only painful and expensive but is often the first event in a downhill series of problems known in medical colloquialism as "The Dwindles". The injury threatens by blood loss and embolization but the further immobility often leads to severe depression, neglect of nutrition and increased liability to infection. The early ambulation used in modern orthopedic practice has helped avert this cycle but no significant progress has been made in preventing the gait disorder which is the underlying cause of these events.

Differential Diagnosis of Gait Disorder

When the physician is confronted with a gait disorder in the elderly patient there is a wide array of diagnostic possibilities which is partially listed in Table I. The clinical examination will document the presence of elementary neurological signs such as weakness, tremor, chorea, cerebellar ataxia, lower extremity sensory loss, spasticity or rigidity. The bedside evaluation will often have to be supplemented with laboratory investigations. In spite of meticulous evaluation the majority of patients will not show elementary neurologic dysfunction which would allow the physician to make a specific diagnosis or even determine the pathogenesis of the problem.

Senile Gait Disorder

This term will be used because it does not commit itself to a localization or pathogenesis. Most patients with senile gait disorder will state that they cannot walk because they are "weak". When the examiner points out that they have normal hip girdle and lower extremity strength the patient will say that they are "afraid of falling", "unsteady", or "insecure". When the patient is asked to stand and resist fore and aft displacement by the examiner, forward displacement is effectively resisted but the patient is easily toppled backwards. The only other findings are an array of signs which have come to be accepted as "normal" in an aged population.[4] These consist of quiet deep tendon reflexes at the ankles, distal symmetrical loss of vibration sense and an equivocal response to plantar stimulation or, less often, actual Babinski signs. When the gait disorder is severe, the patient balances with the arms and sometimes will not release the examiner or other source of support. He may actually appear panicky at the thought of standing unaided. A mild gait disorder may grow suddenly worse with even a few days enforced bedrest associated with a minor illness or elective surgery. Gait training sessions with an energetic physical therapy group appears to rapidly restore function to the premorbid level for these patients. Any explanation of the senile gait disorder must allow for the paucity of elementary neurologic signs. This discussion will now turn to five possibilities compatible with this crucial criterion.

Gait Disorder in Normal Pressure Hydrocephalus (NPH)

In normal pressure hydrocephalus the triad of gait disorder incontinence and dementia is associated with enlarged ventricles, a disorder of cerebrospinal fluid circulation and normal cerebrospinal fluid pressure.[5] The noncommittal tern "gait disorder" has been used repeatedly in the literature on the topic in lieu of being able to provide a precise description for specific features of the gait. The patients are "fearful" of falling, tend to hang on and usually can be displaced backwards more readily than forwards. The clinical picture typically improves after cerebrospinal fluid is withdrawn as part of a diagnostic lumbar puncture but deterioration is noted when cerebrospinal fluid is replaced by air for pneumoencephalography. If the fate of a radioistope instilled into the cerebrospinal fluid is monitored by repeated scanning two major abnormalities are found. The enlarged ventricular system is distinctly outlined not only because of the abnormal enlargement of this system but also because there is a paucity of the radioisotope in the subarachnoid space over the convexities which normally obscures the ventricular pattern. Repeated scans reveal a marked delay in absorption of the isotope from the cerebrospinal fluid. The syndrome may develop in the wake of inflammatory states in the subarachnoid space as following meningitis, encephalitis or subarachnoid bleeding. A relative obstruction in the basilar subarachnoid cisterns which impedes the flow of cerebrospinal fluid toward the major parasagittal absorptive areas of the Pacchionian granulations. The flow-absorptive defect is reflected by the abnormal rise in cerebrospinal fluid pressure with a timed instillation of sterile saline into the subarachnoid space.[6]

The clinical syndrome responds dramatically to shunting of spinal fluid into the venous system (ventriculoatrial shunt) in 20-40% of cases. There was a brief period when in some clinics nearly every patient with dementia and large ventricles was given a trial of shunting and the percentage of favorable responses dropped. Despite the availability of excellent physiological (radioisotope, cisternography, CSF infusion manometry) and morphological (pneumoencephalography and CT scanning) parameters reliable prediction of shunt responders is not yet possible. The CT scan now serves as a reliable screening device for this disorder. The CT scan in normal pressure hydrocephalus shows enlarged ventricles which have a rounded configuration rather then retaining their angular shape as do the enlarged ventricles associated with aging and dementia. There also is early enlargement of the temporal horns and IVth ventricles which is not seen in cerebral atrophy. The often noted periventricular irregular areas of low density have become the most recent hope for predicting the shunt responders.

If rigid criteria are applied only a small percent of aged patients with gait disorder will be found to have normal pressure hydrocephalus.[7]

Patients with NPH and only the gait disorder alone (no dementia or urinary incontinence) have been encountered and appear to have an unusually favorable response to shunting.

The pathogenesis of the gait disorder in NPH is an extremely important issue because the difficulty, as in the common variety of senile gait disorder escapes description in terms of elementary neurologic deficits.[8] In infantile hydrocephalus, the associated spastic diplegia has been attributed to stretching of the leg fibers from motor cortex as they (unlike face and arm fibers) circumvent the lateral ventricles to reach the internal capsule.[9] The adult patients with NPH, however, typically do not have obvious corticospinal signs. Involvement of efferent systems from more anterior frontal loci such as the outflow from premotor, frontopontocerebellar or supplementary motor systems might be invoked by a similar mechanisms but the gait disorder does not have the features which make it unequivocally "frontal" (vide infra).

Senile Gait Disorder as an Extrapyramidal Syndrome

The most common extrapyramidal syndrome in the elderly is parkinsonism which is manifested by rigidity, bradykinesia and tremor.. There is a poverty of that category of movement which is the unconscious response to visual, vestibular, tactile and propriceptive input. In full blown parkinsonism there are a series of highly characteristic features affecting mobility. When the patient is asked to stand and walk, the sitting patient fails to flex his legs closer to his center of gravity and experiences difficulty in rising from the chair. When standing, the posture is one of flexion at knees, hips, trunk, neck and elbows; the shoulders are adducted. The center of gravity may now be too forward and the patient may have to continuously acclerate (festination) in order to prevent a fall forward. Otherwise the gait tends to be slow, with small shuffling steps. Loss of ankle movements remove the spring from the gait and there is a loss of associated movements such as, arm swing and hip and shoulder rotation. Thus, the patient walks and turns with the entire body fixed into unit ("en bloc") which compromises the balance and stability of the gait.

In parkinsonism there is a loss of cells in the substantia nigra of the midbrain. These cells elaborate dopamine which passes along the nigrostrial system to be released in the caudate and putamen where dopamnergic influences are counterbalanced by cholinergic systems.[10] In idiopathic and postencephalitic parkinsonsim there is an absolute deficiency of dopamine while in drug-induced parkinsonism there is relative deficiency of dopamine because of dopamine receptor blockade and enhanced cholinergic activity within the caudate and putamen. Oral dopamine does not reach the brain but oral L-DOPA, a dopamine precursor does enter the brain and result in increased production of dopamine. The result has proven to be a very successful drug for parkinsonism. The newer forms of L-DOPA are combined with a peripheral DOPA-decarboxylase inhibitor which eliminates the gastrointenstinal and vascular side effects of the L-DOPA. As the disease progresses the continued fallout of nigral cells reduces the amount of dopamine production in spite of abundant L-DOPA substrate. The central nervous system side-effects (psychosis and dyskinesias) appear with ever decreasing doses of L-DOPA. These adverse responses are either the result of L-DOPA effects on other parts of the brain or due to metabolism of the L-DOPA in other pathways (O-methyl transferase) resulting in substances with toxic effects...

Once again, as with NPH, parkinsonism and other clearcut extrapyramidal disorders will be identified in but a small proportion of patients with senile gait disorder. Could a significant number of senile gait disorder patients be manifested as very subtle early form of parkinsonism? Many clinicians after noting the slow small steps of senile gait disorder and have empirically treated with L-DOPA. The result is an anecdotal impression of some clinician that L-DOPA improves the common type of senile gait disorder. Unfortunately, no controlled clinical trials have been done.

There are some research data of relevance to this approach. Aging humans and animals show decreasing concentrations of dopamine in the nigrostriatal pathways.[11] Aged mice swam with hindquarters well below the surface of the water as compared with young control animals. Treatment of the aged rats with L-DOPA returned the swimming posture to that of the younger mice.[12] The effect of the L-DOPA on mobility is most likely mediated within the nigrostriatal system, but there may be many other sites of action. Denny-Brown has recently demonstrated a remarkable spinal effect of L-DOPA in altering the area of receptivity in isolated single nerve roots in the monkey.[13]

The situation is then one where clinical impression conspires with a theoretical-experimental basis for L-DOPA deficiency playing a role in the altered mobility of aging and demands that a controlled quantitative assessment of L-DOPA therapy be tried in non-parkinsonian patients with gait disorders. There are two minor clinical points that suggest a negative outcome for such trials. Patients with senile gait disorder tend to have entirely normal dextrous use of the hands. Aged patients with great difficulty in walking about will have no problem using their hands in playing musical instuments. Yet parkinsonism does not tend to involve only one of the limbs; hemiparkinsonism exists but not lower extremity parkinsonism. In the common variety of senile gait disorder the tendency is to fall backwards, while most parkinsons patients fall forward. Extensor parkinsonism has been described, particularly in the postencephalitic variety. Patients with progressive supranuclear palsy also have a tendency to extensor postures.

Senile Gait Disorder as a Pyramidal System Disturbance

The bipyramidal gait may be seen with spinal cord disease or bilateral disease in the brain stem or cerebral hemispheres as in multiple sclerosis, cerebral palsy, motor neuron disease, multiple lacunar infarctions or metastatic disease. The lower extremities assume a posture of hyperextension and adduction. The gait is marked by delayed hip flexion and the toes may scrape the waking surface due to failure of dorsiflexion at the ankle. The first detectable weakness in pyramidal lesions affects the flexors of the hips, knees and ankles with similar degree of involvement in the hip abductors. Spasticity, hyperraflexia and extensor plantar responses are also present.

Obviously, this picture has little in common with the senile gait disorder patient. There may be a tendency to develop extensor plantar responses with aging and an alteration in extensor posturing might be associated with a tendency to fall backwards.[14]

The full blown pyramidal syndrome is the result of destruction of the precentral motor strip or its efferent pyramidal (corticospinal) pathway. A highly selective lesion in a subset of this system has recently been demonstrated in the aged human brain. Scheibel et al. studied the pyramidal cell population of the precentral gyrus of human brains in patients 74 to 102 years old.[15] There are millions of pyramidal cells in each motor cortex but only about 40,000 giant pyramidal cells of Betz in each hemisphere. In each of their specimens 75% or more of the Betz cells show age-linked changes but less than 30% of the other pyramidal cells show similar changes. The Betz cells progressively lose dendritic spines and dendrites beginning with simplification of the basilar dendrites and ultimately the apical dendrite is lost. These senescent Betz cells appeared vulnerable to engulfment by astroglia. The rapidly conducted Betz cell efference is largely directed (75%) to motor areas supplying the leg.[16] Physiological studies indicate that Betz cell output interrupts antigravity tone as prelude to voluntary motor activity.[17] The effect of the loss of this function might be to enhance extensor tone and inability to relax this tone prior to voluntary motor acts could lead to gait difficulty and a tendency to fall backwards. Scheibel et al postulate that the loss of Betz cells with aging "might well contribute to the familiar stiffness in joints of the lower extremities and hips and the slowing down in motor performance and agility which is so characteristic of age".[15] When a cell-specific lesion occurs the resulting clinical picture may be quite different from that caused by total [illegible]ction of the same region. For this reason a "Betz cell syndrome" may be quite different from a motor cortex lesion and the lack of spasticity, paralysis, hyperreflexia and extensor plantar responses need not be a serious objection to the theory. The rapid recovery following surgical ablation of the cerebellar cortex is in striking contrast to the profound permanent ataxia resulting from selective Purkinje cell death with hyperthermia.

Senile Gait Disorder as a Frontal Lobe Syndrome

The motor effects of premotor and prefrontal lesions have been the subject of much controversy and study since Bruns' paper on frontal ataxia in 1892[18]. In today's practice the patient with senile gait disorder is most commonly given the label "frontal gait", "frontal ataxia", or "frontal apraxia of gait". The high frequency of senile dementia - Alzheimer's disease and senile gait disorder may have caused the two entities to become erroneously linked.

Senile dementia or Alzheimer's disease begins with temporoparietal deficits (nominal aphasia, spatial-constructional difficulty, and retentive memory disorder) and these are well established before frontal signs develop. Many severely demented patients walk normally and many patients with senile gait disorder have no trace of dementia.

Frontal Ataxia The original descriptions of frontal ataxia were in patients with massive frontal tumors and it was thought that either the mass effects were distorting posterior fossa structures or the effect was the result of disturbance in the frontopontocerebellar system.[19,20] The disturbance in gait with frontal lobe tumors was said to resemble cerebellar ataxia so closely that ataxia was considered a false localizing sign in the neurosurgical era prior to ventriculography and arteriography. In recent times particularly since the advent of CT scanning, tumors are detected and treated early and the issue has not attracted much attention. The mass effect in these frontal tumor patients may have been a necessary condition for the appearance of the ataxia, for if the tumor was removed the gait disorder improved. Furthermore, patients with frontal lobotomies where the frontopontine system was transected had not gait disturbance.[21] It may be reasonably concluded that a search for a frontal tumor should be made in the elderly with ataxia but most diseases of the frontal lobe do not cause cerebellar type of gait disorder.

There is another less specific disturbance of motor behavior noted with frontal lobe lesions. Damage to the premotor cortex causes a difficulty in performing complex motor tasks generalized in time. The patients seem to be unable to erase one movement in order to move smoothly on to the next. Luria has pointed out the extreme difficulty such patients have in alternating from one hand posture (fist) to another (forming a circle with the thumb and index finger).[22] There may also be an abnormality in muscle tone known as "gegenhalten" or counterholding. When the patient is instructed to let a limb, become limp, the examiner notes normal resistance to passive joint movement but a resistance soon appears which builds in concert with the amount of force supplied by the examiner. When the examiner desists the patients increased tone melts away. This phenomenon is often mistaken for patient uncooperativeness.

The grasp, suck and snout reflexes which are present in normal infants reappear with disease of the frontal lobe. Denny-Brown attributed frontal gait disorder to the release of the contactual grasp reflex in the feet.[23] When the patient's foot touches the floor the contact becomes the stimulus for the magnetic or tonic grasp reflex. The patient becomes "glued" to the floor and sways sideways to lift a foot from the floor, Upon finally succeeding he makes a few small steps, then the gait improves and steps become somewhat longer. The major trouble is in the initiation of gait. Clinicians have described the burst of small steps when starting off as the "slipping clutch syndrome". The motor performance of the foot improves when there is no contactual stimulus on the plantar surface, as when the patient traces a circle in the air with his great toe. The patients with this variety of frontal gait disorder have full blown frontal syndromes with grasp, suck and snout reflexes as well as gross frontal behavioral changes. This gait abnormality would not be the basis for the commonest variety of senile gait disorder since these patients are not demented.

Frontal Apraxia of Gait This term was first used by Gerstmann in 1926 who thought that a gait disorder would appear if a prefrontal lesion spread to the anterior corpus callosum.[24] Denny-Brown used the term apraxia to describe the patients with magnetic grasp reflexes in the feet.[23] There is a semantic problem in the use of apraxia for this condition. A satisfactory definition of apraxia would include a failure to perform a learned motor act where the patient has no elementary neurologic deficits, understands the request, is cooperative and where a testing circumstance can be devised which normalizes the performance. If the magnetic grasp reflexes are counted for an elementary neurologic sign then apraxia would not apply to that variety of frontal gait disorder. No fully similar disorder has been described to fulfill all of these criteria as an apraxia of gait.[25]

Senile Gait Disorder as a Peripheral Neuropathy

The usual patient with senile gait disorder has dampened distal reflexes and distal loss of vibration sense. These clinical findings have been viewed as "normal" in the aged population but are in fact signs of a peripheral neuropathy.[25]

In addition, to this clinical evidence for a neuropathy of aging there is also morphological and physiological data which document this neuropathy. Progressive slowing of maximal nerve conduction velocities, especially in the distal lower extremities occurs with aging.[27,28,29,30] There is a fallout of 5-8% of the fibers in peripheral nerves per decade after age 40 and the largest fibers are most affected in this process. A significant reduction in the average internodal length accompanied this process. There is an average loss of 0.15 meters per second per year with advancing age.[31,32,33,34,35,36]

The largest most rapidly conducting peripheral nerve fibers arise from the nuclear bag portion of the muscle spindles. Involvement of these fibers in the neuropathy of aging could cause an impairment of motor performance in the absence of clinically detectable sensory disturbance of paresis. The nuclear bag portion of the muscle spindle has viscous properties which result in rapid distortion-restoration behavior with muscle stretch.[37] The IA fibers send rapidly fatiguing bursts of impulses with each change in shape of the nuclear bag. This phasic information gives data regarding muscle stretch. The message results in spinal reflex contraction of the stretched muscle and inhibition of its antagonist. Although this system was viewed as an unconscious error detector there is now ample evidence that the IA afferent information also makes a contribution to the conscious perception of movement and position.[38,39,40,41]

The most interesting and compelling proof of the conscious appreciation of IA afferent information relates to the effect of vibrating a muscle or its tendon. The low viscosity nuclear bag portion of the muscle spindle is able to follow the rapid distortion-restoration sequence imposed upon it directly or via the muscle tendon with a 100-200 cps vibrator of the type used in physical therapy departments. Inasmuch as the nuclear bag is almost continuously changing shape a continuous firing of IA fibers develops as though the muscle was being stretched. This is accompanied by the perception that the limb is moving opposite the direction of action of stimulated muscle. For example, if the biceps tendon of a blindfolded normal subject is vibrated an involuntary elbow flexion ensues. If the subject is asked to match the position of the vibrated limb with his other side there is a constant error of about 8 degrees less elbow flexion in the nonstimulated limb. In normal subjects this illusion can be greatly exaggerated by passive extension of the muscle being vibrated. The errors in perceived position now rise to 22 degrees. If the elbow is passively extended while the bicep is vibrated, the subject will report the sensation of full elbow extension while the elbow is still flexed. When passive extension is continued beyond this point the subject perceives an anatomically impossible state of hyperextension at the joint.[42] The subject becomes disturbed and may show the autonomic accompaniements of pain although the experience is not painful. Some normal subjects experienced two forearms; one in the anatomically impossible position and another in the actual position. These observations indicate that the conscious perception of limb position is made from analysis of at least two different types of afferent information. The joint and tendon receptors give a constant measure of joint angle while the IA spindle afferents contribute to the sensation of movement.

The aged individual with loss of IA afferents in the lower extremities combined with some visual impairment and a minor loss in precison of joint sensibility might have to recalculate his position after each step. There would be a loss of the measure of movement as it took place and a consequent disruption of the flow of gait.

If senile gait disorder is due to a neuropathy there is no problem with lack of correlation with cortical signs. Since the longest fibers are most affected, the disorder is limited to the lower extremities and this is compatible with the excellent upper extremity motor function in patients with severe gait disorder. Furthermore, the clinical signs and other data clearly document the occurrence of a neuropathy of aging. This hypothesis simply impugns this neuropathy with clinical significance.

There is one additional feature of senile gait disorder which can be explained on the basis of a peripheral neuropathy, i.e., the tendency to fall backwards. Nearly all of the hereditary metabolic, toxic and nutritional polyneuropathies show precise evolution of clinical deficits according to axonal length. The motor or sensory deficits begin in the longest fibers and progress very precisely according to decreasing axonal length.[43] The fibers supplying the anterior tibial compartment are some 10cm longer than those to the gastrocnemious-soleus group.[44] In a slowly progressive neuropathy with loss of IA afferents the anterior tibial compartment would lose these fibers long before the gastroc-soleus group. In this situation when the patient attempted to maintain stance and contracted both groups of muscles a volley of IA would arise from the gastroc-soleus. This volley would cause reflex contraction of the gastro-soleus and inhibition of the anterior tibial compartment and the patient would tend to fall backward. This situation can be simulated in the normal subject by simultaneously vibrating both Achilles tendons. There is an asymmetric IA input which causes the subject to fall backwards.[45] Simultaneous vibration of both anterior tibial compartments causes the normal subject to fall forward.

I have made preliminary observations on the effect of vibration in 6 patients with senile gait disorder. All appeared to have enhanced vibration induced falling from posterior compartment stimulation. No forward falling could be induced in any of them with anterior tibial compartment vibration and two continued to fall backwards presumably due to transmission of the vibration via bone to the posterior compartment. None of these patients showed dorsiflexion of the foot when the anterior compartment was vibrated while the patient was lying down.

Such an imbalance in afferent information from flexors versus extensors would cause chronic disability because constantly varying erroneous information is usually not well compensated by central mechanisms. This is analgous to the chronic vertiginous syndromes with partial injury to the vestibular mechanism versus excellent compensation which occurs after the acute vertigo of a complete transection of one vestibular nerve. This distorting effect of fiber length might form the basis for both the chronicity and tendency to fall backward in senile gait disorder. The hypothesis that peripheral neuropathy forms the basis for senile gait disorder has appeal on several grounds.

1. It is compatible with all the clinical features of senile gait disorder.
2. Unlike most of the cerebral syndromes the neuropathic syndrome might be treatable. Selective nerve blockade, vibrator induced spindle overload or the provision information regarding muscle stretch by an electronic transformation of the data into auditory signals are examples of treatment methods that might be attempted.
3. The hypothesis is testable utilizing simple bedside examination and studying the tonic vibratory response of the leg muscles. Histological examination of the peripheral nerves and spindles in autopsy material and applied neurophysiological techniques could also readily be carried out to test the hypothesis.
4. The stigma of "frontal" or other cerebral syndromes would be elimated.

Summary

Gait disorder in aging is so ubiquitous that even actors will change their walk when playing the role of an aged individual. Vascular disease and arthritis may play a role but the dominant problem appears neurological. Each patient deserves thorough evaluation in order to diagnose and where possible treat specific clinical entities such as, combined system degeneration of the spinal cord due to vitamin B12 deficiency, parkinsonism, cerebral tumors, myelopathy due to cervical spondylosis or normal pressure hydrocephalus. Even with skillful and meticulous diagnostic examination, most of the patients will turn out to have no identifiable disease and will be mislabled with a term such as, "frontal apraxia of gait". This paper has attempted to analyze some of the possible neurologic basis for senile gait disorder. Based on these observations certain recommendations may be submitted.

Assessment of Gait

The clinician may be quite skillful in detecting subtle gait abnormalities, but these observations are subjective. An objective method of assessing gait is one of the most pressing needs. This would be critical for differential diagnosis and essential for evaluating the efficacy of therapeutic maneuvers. A multidisciplinary group with input from neurologists, physical therapists, bioengineers and computer software engineers could devise a satisfactory method with available technology. The movement of key labeled points on the body (toe, heel, ankle, knee, anterior iliac spine, occiput and wrist) could be recorded on videotape and undergo computer analysis. Frictional-shear forces as the subjects walked at fixed rates across standard textures could be measured. Normal age and sex control data could be compared with data gathered from patients with known diseases and senile gait disorder could be characterized and perhaps specifically diagnosed by these objective parameters.

Treatment Trials

The effectiveness of L-DOPA and other therapeutic maneuvers might be readily tested if an objective method of testing were available. The deleterious effects of drugs such as, phenothiazines and haloperidal which are commonly used in elderly populations also could be documented. A critical level of gait deterioration could be identified in these and other patients which should place the patient at high risk for a hip fracturing fall.

Bioengineering studies of stability during the gait might allow the production of a device which would give an auditory signal before a dangerous degree of instability developed during the patient's ambulation. The methods of treating gait disorder based on the neuropathic hypothesis of etiology could be tested.

A multidisciplinary approach aimed at mastering the problem of senile gait disorder would economically justify itself if the incidence of hip fracture could be lowered even slightly.

TABLE I

Some Neurological Disorders with Gait Disorder and Falling

	Elementary Neurologic Signs Present	Diagnostic Studies	Treat
A. Degenerative Disorders			
Alzheimer-senile dementia	+/o	0	0
Cerebellar degeneration (alcoholic, idiopathic)	+	CT Scan	0
Olivopontocerebellar degeneration	+	CT Scan	
Progressive supranuclear palsy	+	0	
Huntington's Chorea	+	CT Scan	0
Parkinson's disease	+	0	+
Motor neuron disease	+	Electromyography	0
Cervical spondylosis	+	Myelography	+
B. Neoplasia			
Frontal butterfly glioma	+/o	CT Scan	+/o
Subfrontal meningioma	+/o	CT Scan	+
Posterior fossa tumors	+	CT Scan	+/o
Metastatic tumors	+	CT Scan	+/o
C. Toxic-Metabolic Disorders			
Tardive dyskinesias	+	0	+
Dilantin Toxicity	+	serum levels	+
Non-Wilsonian hepatolenticular degeneration	+	serum ammonia	+
Metabolic neuropathies (nutritional, diabetic alcoholic, paraneoplast	+	Electromyography	+/o
Subacute combined systems disease	+	Serum B12 level	+
D. Diseases with altered immune response			
Myasthenia gravis	+	Tensilon Test	+
Multiple sclerosis	+	CSF immuno globulins	0
Polymyositis	+	muscle biopsy	+
Guillain-Barre Syndrome	+	CSF Electromyography	0

TABLE I (CONT.)

	Elementary Neurologic Syndromes	Diagnostic Studies	Treatable
E. Infectious			
General paralysis	+	CSF test for syphillis	+
Jakob-Creutzfeld disease	+	brain biopsy	0
Chronic basilar meningitis (crytococcal, sarcoid, other fungi)	+/o	CSF studies	+
F. Disorder of Spinal Fluid Flow			
Normal Pressure Hydrocephalus	+/o	CT scan Istope Cisternography	+
G. Episodic Disturbances			
Seizure disorders	0	EEG	+
Transient ischemic attacks	0	Arteriography	+
Postural hypotension	0	BP determination	+
Cardiac arrhythmias	0	Holter monitor	+
Aortic stenosis	0	Several	+
Vestibular disorders (Meniere's disease)	0	audiometrics	+/o
Benign postural vertiog	0	electronystagmography	+/o

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Circumstances of Death in the Elderly -- A Review of the Literature

by

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Circumstances of Death in the Elderly -- A Review of the Literature

INTRODUCTION

This review will attempt to identify and evaluate "when, "where", and "how", death occurs in individuals aged 50 and older. Although the world literature was searched, only those works in English published from 1930 to the present are abstracted and critiqued here. In addition, a separate bibliography is appended which notes relevant studies which have been published in other languages.

Each study reviewed will be discussed within that topic section -- where, when, or how -- to which it belongs. In the event a single work addresses more than one of these broad topics, that work will be analyzed within the section most appropriate to its major focus. In the first section, "Where the Elderly Die", works are discussed which describe the physical settings in which the aged die. The "when" of death refers to the timing of an individual's death. Included in the section entitled, "When the Elderly Die", are studies which discuss patterns in the yearly and daily distributions of deaths. "How" these individuals die is the topic of the final and largest section -- "How the Elderly Die". This section is limited to studies addressing one or more of the following 8 major issues:

1. Was a physician present at the time of death?
2. Was the patient conscious or not during the terminal period?
3. Did the patient die in pain or in other distress?
4. Was the patient depressed during the terminal phase?
5. Did the patient die while asleep or while awake?
6. Was death expected by the patient and/or the staff or did it come about suddenly and unexpectedly?

7. Does the attending medical staff have information on the prior illnesses of dying patients?

8. How frequently and under what circumstances are autopsies performed on these patients?

The pertinent literature on deaths from all causes, except homocide and suicide, is considered. Although it is realized that the biologic mechanism of death specific to a given disease or injury will often influence these issues of where, when, and how, an analysis of these issues by cause of death is not a major objective of this paper. Also, an effort has been made only to include papers reporting actual research on the topics of interest. The large literature based on untested, clinical impressions has been largely excluded. Summary remarks and some comments on the overall state of this literature are provided in a concluding section.

WHERE THE ELDERLY DIE

If the U.S. and British experience is a time indicator, then it can be concluded from this literature that the elderly in Western industrial cultures are more likely to die in a hospital than in their own homes. In recent years, the welfare home has also become an increasingly "popular" terminal setting. As this literature demonstrates, there is disagreement between various sectors in the medical and lay community as to the optimal environment for care of the terminal patient. The "optimal" deathbed depends on specific patient needs and on the facilities available in a given community.

Glyn Hughs reports an ambitious project; which was designed to document "all the problems of terminal care for persons with a restricted expectation of life." ("restricted expectation of life" = 12 months or less). (Glyn Hughs, 1960). This survey was conducted between November 1957 and December 1958; its design was based on the geographical pattern of the British National Health Service. Data were amassed using mail questionnaires returned by physicians, hospital statistics, and visits by the research staff to a cross-section of every type of establishment (including homes of patients) in which terminal care might occur. Although the sampling and data collection seemed quite sound, not enough detailed information was provided in the report to reach a final decision on the methods of this survey and on the generalizability of its results. Mortality data were not restricted to any age category; most death rates reported were of cause of death irrespective of patient age.

In 1956, 40% of all deaths in Britain occurred in National Health Service hospitals. Of the remaining 60% which occurred outside these hospitals, 82.4% occurred in the patient's own home. Therefore, nearly 50% of the total number of deaths took place at home. Mortality data were tabulated in 6 categories of death site -- N.H.S. hospitals, medical institutions other than N.H.S. hospitals, other institutions, person's own home, mental health establishments, and "elsewhere". This "elsewhere" category accounted for only about 4.8% of all deaths, and it includes such sites as hotels, boarding houses, public places, and on the street.

The remainder of this report was concerned with comparisons of the facilities for terminal care provided by various types of institutions, regional demands for and problems in obtaining hospital beds for terminal patients, the role of the family during terminal illness, and the reactions of patients upon learning the seriousness of their condition. Although touted as a comprehensive study of all death and dying issues, the problems of pain management and changes in mood and consciousness during terminal illness were mentioned only in passing and were not among the issues systematically researched in this project.

Lerner collected data on the circumstances of death in the United States (Lerner, 1970). He traces the changes in lifespan which have occurred through the years and he comments on the "major killers" and the lives they claim. Of most interest is his review of the sparse information on "where" Americans die. Lerner states that "where people die — in a hospital or other institution, at home, or in a public place — has been a relatively neglected aspect of mortality statistics in this country during the past few years." The national statistics for 1949 show that in that year 49.5% of all deaths occurred in a hospital or other health care facility; by 1958 this figure rose to 60.9%. National data is lacking for years after 1958, but tabulations compiled since then by a variety of states and cities confirm the continuence of this trend toward in-hospital dying. In general, these data show deaths at home to be dropping (for New York City, from 31.4% in 1955 to 24.2% in 1967), deaths in hospitals and other medical institutions to be rising (for New York City, from 65.9% in 1955 to 73.1% in 1967), and deaths on the street and in all other places to be remaining constant since the 1950's at about 3% (for New York City, from 2.8% in 1955 to 2.6% in 1967). These general trends hold fairly well across all segments of the U.S. population, but data are given on how these overall patterns vary somewhat according to geographic region, race, and disease.

A 6-year comparison of mortality in age-sex matched elderly populations in a Birmingham, England welfare home and in a Birmingham area general practice by Pike showed statistically significant longer survival in those outside the welfare home (Pike, 1972). The total welfare home population consisted of 62 individuals (48 females and 14 males); a similar number of subjects were drawn from the general community. Admission to the welfare home was for a variety of medicosocial or purely social reasons; all individuals in the study were believed to be of similar socioeconomic background. It was not clear how socioeconomic class was determined. All deaths that occurred were atrributable to common chronic geriatric causes.

The reason(s) for the noted mortality differences could not be determined. Pike speculates that the nursing home individuals were either initially sicker and/or less physically active in the welfare home environment and therefore more obese than the individuals living in their own homes in the community. Both hypotheses should be easily testable using the available medical records; neither idea was investigated in this study.

An introductory paper delivered by Surgeon Rear Admiral J.M. Holford attempted to document "where" people die in Britain. In 1965, 38% of all deaths (all ages) occurred at home and 50% occurred in non-psychiatric hospitals. The remaining 12% of deaths were left unspecified as to location in this report. Contrast these 1965 figures to 1970 rates for total deaths -- 33.5% at home and 54% in non-psychiatric hospitals (remainder again unspecified). There is clearly a trend away from home terminal care and to hospital care. If only cancer deaths are considered, the same relationship holds. The data presented here were unreferenced.

During this same conference, Dr. E. Wilkes reported results from his cancer survey in Sheffield, England. These results supported Holford's previously cited observation that the trend is to die in the hospital and not at home. It was also noted that the majority of patients (age unspecified) observed dying at home do not experience significant pain or distress. Only 10 to 15% had unfulfilled medical needs (also reported in Wilkes, 1965).

B.J. McNulty contributed to the conference by citing observations based on work with 784 dying patients having some contact with St. Christopher's Hospice, London, during the period October 1969 to October 1972. This work documented rather well both the problems and the great benefits to patient, family, community, and medical staff resulting when the dying are allowed to expire in their own homes. Of the 784 patients followed, 86 were able to die at home by their own wish. The ages and method of selection of the individuals comprising the sample were unfortunately not indicated. The number of patients able to die at home is largely dependent on the effective operation of hospital-based domiciliary services such as the one evaluated in this survey.

Although predominantly aimed at describing differences in hospital admission rates, Cordle and Tyroler's large scale cross-sectional evaluative research also provided some good information on black-white differences in hospital mortality experience (Cordle and Tyroler, 1974). All admissions to and deaths occurring in the hospitals serving the biracial population of Charleston County, South Carolina were surveyed for the year 1963. Each of these hospitals served as a teaching hospital for the Medical College of South Carolina; the entire population at risk for hospitalization during 1963 was well defined and numbered 215,000. Effort was made to include Charleston County residents who happened to be hospitalized in neighboring county hospitals. In-hospital mortality of individuals aged 35-64 was investigated. Whites in this age group were 4.5 times more likely to be admitted to a hospital than were blacks in the same age group. However, blacks once admitted to the hospital, were 7 times more likely to die in the hospital than were whites. The authors speculated that blacks who gained hospital admission were more seriously ill than their white counterparts. The admission rate for whites in these Charleston hospitals compared favorably with that for whites reported in other U.S. hospitals; the overall hospital admission rate for blacks in the U.S. was 1.4 times that for blacks in Charleston.

The work of Cordle and Tyroler is valuable and appropriately included here in that it alerts us to beware of the ecological fallacy in the broad survey works which dominate this literature and were reviewed here. "Where" our elderly die is certainly very much dependent on the sociodemographic variables, such as race, which characterize these individuals.

WHEN THE ELDERLY DIE

The "when" of death literature embraces studies of 2 general phenomena -- personal timetables for death and seasonal factors predisposing individuals to death. Research on personal timetables will be considered first; it is a literature unfortunately dominated by uncontrolled reports on small samples of "interesting" cases. Larger research efforts such as the Alderson (1975) survey on birthdate and month of death, and Feinleib and Fabsity's (1978) work on biorhythm and day of death, are inconclusive and show either no or slight, confusing relationships between personal life cycle factors and time of death. The relationship between season and death is better understood and is substantiated by a number of large, thorough investigations which will be considered in this review. There is general agreement that in the industrialized nations, significantly more deaths occur in the winter than in the summer and that this seasonal variability is most pronounced in the elderly age groups. Feinleib et al. (1975) and Biersteker and Evendijk (1976) unsuccessfully attempt to explain some seasonal death patterns on the basis of geomagnetic storms, and photo-chemical oxidant air concentrations. Although a detailed analysis of the topics of death due to heat or cold exposure are beyond the scope of this review, these issues will be touched upon in both this and the following section when they come up in the literature documenting the when and how of death in the elderly.

Personal time tables for death

Fischer & Olin collected 10 case reports and a variety of historical anecdotes demonstrating Hilgard's classical anniversary reactions and/or the operation of emotionally invested deadlines (Fischer & Olin, 1971). Such intrapsychic stress can predispose individuals to fatal illnesses; it is believed that some patients harbor accurate, self-fulfilling expectations about the time or circumstances of their own deaths. These patterns are part of the conscious and unconscious will of the individual, they may be indicators of psychopathology, and they can often be favorably influenced with psychotherapy. Along the lines of their 1971 work, Fischer & Olin in 1972 published a loosely organized, unconvincing collection of case histories demonstrating the psychogenic time patterns and factors contributing to man's illness onset and death (Fischer & Olin, 1972). In all, 9 cases are presented -- 6 examples of "emotionally-invested deadlines", 2 reports illustrating Hilgard's "classical anniversary reaction", and 1 history demonstrating a subject's unrepressions and stress on the annual anniversary of a heart attack which happened to also occur on a religious holiday. Fischer and Olin's argument for the importance of personal psychogenic determinants of time of death is further supported by anecdotes from the non-medical literature on the timing of the deaths of American historical figures.

Alderson analyzed mortality data of persons aged 65+ in England and Wales for 1972 (N = 255,164) in order to examine the relationship between month of birth and month of death (Alderson, 1975). To remove any seasonal effect in either the month of birth or month of death, each individual was regarded as dying in a specific month relative to his month of birth, ranging from 5 months before (-5) to 6 months after (+6). Using Edwards test for seasonality, it was possible to test for any cyclic trend in this distribution for the 12 classes (month of birth, month before and after birth). For persons 75 and over in each of 8 subgroups (4 marital status categories for each sex) there was a consistent trend in deaths with an excess in the birth month and in the following 3 months. Compared to expected rates, death rates preceeding the birth month were low. The excess observed was of the order of only 1% of all deaths in the year, but it was statistically significant for each subgroup. No pattern emerged for deaths in individuals aged 65-74. The author hypothesized that birthdays in 75+ year olds in some unknown subtle way undermines the morale and therefore the health of these individuals. Such an explanation is purely conjectural at this time. No explanation is given for why a similar lowering of morale does not occur in, for instance, the 65 year old. The data were not analyzed by cause of death.

Roger published a useful statistical critique of the analysis on the previously cited, Alderson (1975) data (Roger, 1977). Roger believes that Alderson's numerically small, although statistically significant relationship between birth and death month in 75+ year olds is an artifact and created by the sampling procedure employed. The population at risk of dying within any given year can vary due to two main opposing effects. As the age-specific mortality increases with age, the number of deaths will tend to increase. However, as the population at risk decreases, due to both earlier mortality and a smaller cohort as defined by year of birth, the actual number of deaths will tend to decrease. Roger contends that if Alderson took account of these subtle, progressive month by month changes in the population at risk, his observed birth-death month relationship would disappear.

The brief report of Feinleib & Fabsity related the results of their statistical analysis of 960 deaths (both sexes and all ages) and their relationship to day of death personal biorhythms (23 day and 28 day cycles) (Feinleib & Fabsity, 1978). No correlation was detected; abnormally high death rates do not seem to occur on critical days in the biorhythm cycle.

Season and death

In an exhaustive comparative survey of national mortality data in Wales, England, and the United States, Lewis-Faning finds that fatal respiratory infections are more prevalent in the British Isles and cause higher winter overall death rates in Britain than in the U.S. whereas the lower summer overall rates in Britain as compared to the U.S. can be largely attributed to the lower prevalence of summer deaths from heart disease and from violent crimes (Lewis-Faning, 1940). The preventive implications of these findings are stressed. Except in the case of bronchitis and pneumonia, age breakdowns of death by specific cause is unfortunately not indicated in the Lewis-Faning report.

Macpherson et al., studied the Lidcombe Hospital, Sydney, Australia population during the year 1963 and attempted to detect patterns between mortality and daily ambient (3:00 p.m.) air temperature (Macpherson, et al., 1967). All subjects were chronically ill adults; this study was not limited to the geriatric age group.

Temperature effects began to be noticed in patients from age 70 on; these effects were most pronounced in the oldest individuals. The effect of successive hot days appeared to be cumulative; such a cumulative pattern was not found for cold days. The author's concluded that overall, "in the relatively mild climatic conditions prevailing, the effect of unfavorable temperatures was small, possibly having some part in 6.3% of all deaths."

This study could have been more informative if the mode of death and if the physiologic temperature-coping ability of patients had been noted. Also, a single temperature reading per day, in a single location, may not have been sufficient. References from this article lead to a vast literature correlating weather with death (about 80 articles between 1930 and 1967).

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Momiyama conducted a detailed compilation of morbidity and mortality statistics from 1900 to 1960 for various diseases in Japan, the U.S., Egypt, the U.K., France, Germany, and Denmark (Momiyama, 1968). Monthly differences in disease frequencies for each disease were noted and this prompted the author to prepare a seasonal disease calendar which summarizes these trends by country and by period. Such a calendar represents deaths in all age groups; this technique can of course also be used in plotting deaths specifically in the elderly.

Social conditions, more so than seasonal and climatic changes, must be invoked to explain the trends noted. In Japan, the U.S., and in the highly industrialized European nations, the mortality peak has shifted from the summer to the winter for most diseases. This is attributed to the sophistication and general availability of medical services and the high baseline level of public health in these countries. In such countries, summer diseases (such as food poisonings) have been arrested but winter ailments are still quite prevalent. In these industrialized nations, deaths come increasingly in winter from all kinds of diseases, including those which formerly raged in summer. Of course, the age structure of a population must be considered in explaining these patterns. The author predicts that in the industrial nations, as medical and public health services advance, variation in mortality will be deseasonalized. In emerging nations, a high summer mortality and typical seasonal disease distributions are noted. Momiyama states that the threat of winter cold and its effects is a technologically surmountable problem.

In 1978 Momiyama published a review and restatement of his earlier 1968 work on seasonal disease and calendars (Sakamoto-Moruyama, 1978). The only additional observation in this 1978 article is the author's view that along with the creation of heated indoor artificial environments in industrialized nations comes both deseasonality of overall mortality and the introduction of the complex problem of mortality due to man-made pollution.

Lake conducted an analysis of all autopsies in men of age 70 and older at Lidcombe Hospital, Sydney, Australia from July 1, 1963 to June 30, 1967 -- a total of 713 autopsy records (Lake, 1969). The major goal of the study was to document patterns in co-morbid conditions. 50% of the population at risk came to autopsy. Lidcombe Hospital served its community as both a hospital and as a home for the socially or physically incapacitated aged ill. All cases included in this study died within this combined hospital-home facility.

The only section of this report of interest here are the findings dealing with seasonal effects. Despite the fact that the daily hospital and home populations remained almost constant over each 12 month period, winter death rates were twice that of the summer. The deaths in spring were next highest, and those in autumn next lowest. This seasonal pattern was most pronounded in the 80+ age group. The average monthly relative humidity was not correlated with the average monthly incidence of death. The only lesion which was statistically related to season was acute tracheobronchitis.

A 1975 study by Feinleib & associates was a response to a series of earlier Soviet studies which stated that geomagnetic storms were the cause of an observed increase in mortality from MI in several cities within the U.S.S.R. (Feinleib, et al., 1975). The present authors tested the validity of an association of solar activity with daily mortality from cardiovascular disorders in the entire U.S. for the period 1964 to 1966, and the association with monthly mortality for the 8 year period 1964 to 1971. The total number of deaths occurring each day in the U.S. for 1964-66 was obtained from tapes provided by the National Center for Health Statistics. Mortality statistics on a monthly basis were also obtained from the National Center for Health Statistics for the period 1964-71; solar activity data were also available for this 8 year period. Daily solar activity was measured by the index of geomagnetic activity, Ap, as reported by the World Data Center.

The American data did not support the association observed by the Soviets; if any relationship between solar activity and U.S. mortality (coronary heart disease, stroke, and/or total deaths) did exist, it was a slightly inverse association. These American investigators took into account that there could be a lag between occurrence of a geomagnetic disturbance and increased mortality risk; even after accounting for a possible 30 day lag in the effect, no significant relationship was observed. It was concluded that the Russian findings can perhaps be explained by other environmental factors such as weather and pollution conditions. All references cited in this article were in Russian and dated from 1964 to 1969.

A Dutch study by Biersteker & Evendijk was an attempt to observe the effect of high photochemical oxidant air concentrations on daily mortality in urban Rotterdam (Biersteker & Evendijk, 1976). Heat waves rarely affect this city, but the scattered appearance of such days (86°F or more) was noted during 1975 and the combined effect of heat and oxidant pollution could be investigated for that year. Daily mortality was followed during July and August of 1974 and 1975. The daily temperature maxima were provided by the Royal Meteorological Institute for the center of Rotterdam; daily oxidant concentration maximas were similarly centrally collected and reported. Somewhat haphazardly, the author's surveyed the national death statistics for this same period.

It was determined that high temperature alone was correlated with a significant rise in mortality; ozone elevations alone had no discernable effect on mortality in 1974, and that, if any effect existed in 1975, it could be separated from the effect of temperature. The rise in mortality experience occurred mainly in the population group aged 70+. Total daily mortality in The Netherlands also bore this out and indicated that the increased death rate occurred in both small and large municipalities. The conclusion from this national data that urbanization did not play a role in exacerbating the death rate is unfounded because age specific structure of the population at risk in these various-sized municipalities was not taken into account.

HOW THE ELDERLY DIE

This section is devoted to a heterogeneous mixture of research topics; it would be advisable at this point to review the scope of the present section as indicated in the Introduction to this paper. The 8 major issues defined in those introductory remarks will each be discussed here.

In the previous section, "When the Elderly Die", it was determined that winter deaths are the most frequent. Many elderly individuals dying during the cold months expire as the result of a very low body temperature precipitated by dangerously cold home environments. This condition of hypothermia in the elderly has been the subject of much thought by British investigators, and the literature reporting this specific variety of terminal distress will be considered first in an opening subsection.

Those issues, among the 8 major issues which concern how a terminal geriatric patient acts, feels, or is cared for are discussed in a large subsection entitled, "Attributes of the terminal phase." As will be discussed in the text, these studies vary greatly as to their focus and methodology; they all lead to the conclusion, however, that the majority of elderly individuals living in the U.S., Germany and Great Britain, experience a terminal phase which is marked by the absence of physical or mental distress. Although this appears true for the majority, the plight of the significant minority can not be ignored as it remains a deplorable but largely correctable one. The suffering of the dying is a very difficult issue to study objectively, many methodological improvements in this field are necessary before the size of the problem can be determined with certainty. Also, it should be realized that the "when" and "where" aspects often influence these issues of "how"; the converse of this is, of course, likewise true.

A final subsection, "How — associated issues, is devoted to studies that address the remaining major issues or serve as good overviews of this literature on how the elderly die. Spitzer and Folta (1964) studied the issue of expected vs. unexpected death and the difference in reactions of the medical staff to the death; Heasman and Lipworth (1966) provided the only published account documenting the frequency and circumstances of autopsy. Finally, the Hinton (1964) and Kalish (1969) papers provide provocative overviews of this entire, diverse field.

Rees conducted a small (4 patient) clinical study of hypothermia in the elderly due to cold home exposure (Rees, 1958). The primary conditions represented in this sample of convenience were senility, myocardial infarction, acute paraplegia, and diabetic coma. Three of these 4 patients died, and in each case where death occurred, hypothermia complicated the clinical picture and significantly contributed to the demise of the patient. Rees advised slow warming of the hypothermic patient. He also advanced the view that accidental home environment induced hypothermia may be a serious and underdiagnosed condition in the elderly which significantly contributes to the mortality of this age group.

Emslie-Smith reported another small clinical study of hypothermia in Britain due to cold home exposure (Emslie-Smith, 1958). Eight elderly patients developed hypothermia which precipitated their deaths. Electrocardiographic confirmation of hypothermia was discussed.

Duguid and his colleagues described a series of 23 British cases of accidental hypothermia (Duguid et al., 1961). All patients (except one aged 56) were elderly (aged 65+) and all cases arose during the winter and came to a hospital. In only 6 patients did the hypothermic state arise "spontaneously" -- without excessive exposure to cold. In all other instances the hypothermia was caused by cold home environments. Only 7 out of the 23 patients survived their hypothermia. Again, the importance of hypothermia and its contribution to mortality in the elderly is pointed out.

The 1964 article by Taylor contains a collection of case reports and summarizes what is known about hypothermia and its contribution to mortality in the aged (Taylor, 1964). Taylor believes hypothermia is often accompanied by undernutrition and that this combination is especially dangerous. He estimates (on the basis of unreported information) that each year in Britain between 1 and 5 old people (ages?) in every community of 2,500 die from diseases associated with hypothermia. If this figure is measured against a population of 50 million, it indicates a death rate from hypothermia each winter in Britain of between 20,000 and 100,000. The author believes hypothermia deserves to be more often indicated on death certificates, and he feels that this condition is usually undetected by clinicians because the ordinary clinical thermometer does not register temperatures below 95°F (35°C); hypothermia is defined (in 1964) as a rectal temperature below 32.2°C.

Although not specifically a study of the relationship between hypothermia and mortality, the large scale cross sectional survey by Fox and associates does establish the magnitude of the problem of cold exposure in British men and women over the age of 65 and living in their own homes during the winter of 1972 (Fox et al., 1973). Subjects for this national survey were selected at random by a systematic probability sampling procedure. Physiological measurements included mouth, hand, and urine temperature assessments. For each subject, the investigators also collected basic sociodemographic information, attitudes toward the cold, and information on utilization of available medical and social services. The general medical condition of these respondents was not reported. Regrettably, non-response rates were not indicated in this report.

Most of the homes visited were cold with room temperatures below the minimum recommended by the Department of Health. Deep body temperatures below 35.5°C were found in 10% of those studied, and the difference between the skin and core temperature was also reduced in this group. Such individuals are at risk of developing hypothermia since they show evidence of some degree of thermoregulatory failure. These investigators feel that hypothermia is a major health problem in Britain's elderly and, they offer their data in support of Taylor's contention (Taylor, 1964) that hypothermia contributes significantly to the mortality of the elderly.

Attributes of the terminal phase

The terminal stages of life were observed by Howell in 300 patients, ages 65 to 104 at Queen's Hospital, Croydon, England (Howell, 1969). The clinical syndrones found to be associated with the final deterioration were classified into 4 groups:

1. ischaemia (affected 31% of sample)
2. toxaemia (in 15%)
3. unexpected complications (in 25%)
4. incomplete or unsatisfactory diagnosis (in 29%)

No autopsies were performed; this was solely a study of terminal symptomatology. The "true" degree of suffering of these individuals, and the representativeness of this sample of convenience were impossible to assess from this report.

The work of Kastenbaum and Mishara was prompted by the observation that, in general, "old people die alone"; the dying elder, unlike the emerging infant, is in a societally imposed isolation and the circumstances of his death go largely un-noticed (Kastenbaum, Mishara, 1971). Suicide among the elderly has been amply documented and continue to be a significant problem. Other premature deaths in this age group, although not frank suicides, if subjected to "psychological autopsy" can often be attributed to more subtle behaviors that are either consciously or unconsciously self-injurious. The psychological autopsy is an intensive multidisciplinary case approach introduced by

Schneidman and Farberow to investigate instances in which the cause of death was difficult to determine by traditional means (Litman, et al., 1963; Schneidman, 1965).

Kastenbaum and Mishara undertook an exploratory investigation of this phenomenon of self-injurious behaviors among 64 male and 142 females geriatric inpatients in a Michigan state mental hospital. All patients were hospitalized on the basis of chronic, irreversible medical problems; no subject was determined to be psychotic. For a period of 7 days, attendants were asked to look for and record any self-destructive behaviors in these patients. These behaviors ranged from "bumping into things (while walking)" to "eating foreign objects." No control group was utilized, and the definition of "self-injurious" behavior was vague, at best. The only result worth reporting here is that (not surprisingly!) these individuals did indeed exhibit the behaviors that the research team was interested in. A major problem with this work is that all of these reported behaviors were seen by the authors to be potentially life-threatening — they could equally well be perfectly "normal", harmless actions.

This article contains many good ideas for future research; the original research reported must be viewed only as "ground breaking' in a previously unexplored field which deserves and demands careful, controlled research.

Neuringer & Harris designed an interesting study which is unfortunately plaqued by its small sample size (Neuringer & Harris, 1974). These investigators attempted to evaluate the extent of the relationship between death involvement and temporal orientation among hospitalized suicidal, terminal, geriatrically ill, and normal individuals. Each of these 4 groups was comprised of 15 subjects; if matching occurred on any variable, it was not reported. It can be however established that these subjects were, unfortunately, widely disparate on the factors of age and on length of stay in the hospital. The individuals in the non-suicidal groups were carefully subjected to pre-study admission screening for suicidal impulses so that these groups would not be contaminated on this factor. Perception of the passage of time was evaluated by a behavioral estimation of elapsed time, and by a survey of opinions concerning the passage of time.

Suicidal patients, closely followed by the geriatrically ill, overestimated time intervals to a much greater extent than did the normal and terminal patients. The suicidal subjects expressed a great deal of impulsiveness and described themselves as feeling miserable to a much greater degree than did the other groups. It was not at all clear if such warped time perception was truly a precipitating causal agent of self-destructive behavior, or if it was an associated but non-causal factor. Of all the groups, the terminally ill patients reported that they felt the greatest amount of time pressure -- time was "flying by them"; this finding is in agreement with reports in the earlier literature.

Aitken-Swan sought to study the circumstances surrounding the deaths of cancer patients by collecting the recollections of their relatives concerning the terminal weeks (Aitken-Swan, 1959). Any relatives who could provide information appear to have been used. This was a sample of convenience of the relatives of 200 cancer patients (ages unspecified) who died during the study year either at home or in any medical facility within the service area of the Christie Hospital, Manchester, England. It should be emphasized that all information collected reflect the unverified, subjective impressions of bereaved relatives. Information provided by these respondents fell into 5 general categories:

1. Demand for admission of the deceased to hospital or a chronic care facility.
2. Home nursing circumstances.
3. Impressions of deceased's medical care.
4. Impressions of deceased's pain and sedation.
5. Other impressions.

Several results emerged. 85% of these families felt that terminal care was adequate. Only 14% of this group of 200 dying cancer patients were admitted to a hospital or a chronic care facility. An additional 15% wanted admission to a hospital or other medical care institution but could not gain admission. One third of those families home-nursing their dying member spoke of severe strain; the remaining two thirds did not indicate any problems with the nursing experience. 48% of the relatives thought that their patients had less pain than they had expected or considered that pain was adequately relieved. In 18%, a qualified statement was made. In 20% of cases relatives described severe pain which was unrelieved by the measures taken. The overall impression obtained was that, in general, these relatives felt that the general practitioner in charge of care "did everything that was possible", and they were most appreciative to these physicians. Recall that this was a sample of convenience and that perhaps only satisfied consumers of the health care system were selected to participate in this survey.

The important study by Exton-Smith is based on 220 terminally ill patients (80 men and 140 women), all of whom were inpatients in the geriatric unit of Whittington Hospital, London at the time of their death (Exton-Smith, 1961). Ages ranged from 60 to 101; the average age was 80. The pain and general bodily distress attributed to the terminal illness was assessed as was the circumstances of death, the patient's mental state, and the patient's awareness of his condition and surroundings. The personal observations of the attending nursing staff was relied upon for this information; no consistent questionnaire protocol was followed -- the nurses merely recorded any information volunteered by these patients. The grading of severity of pain was an especially subjective determination. ("Did pain respond to aspirin or was a stronger analgesic necessary?").

Only 40% of the patients (88 individuals) were unconscious for 3 hours or more before death, another 34 died suddenly, often in their sleep, the remainder (98) died while awake and lucid. At least 25% of all patients realized they were dying. Most of the patients who died while lucid were calm at the hour of their death. How much the medication schedules of these patients influenced all of this is impossible to determine from this article. A total of 21.3% of these patients complained of at least moderate pain and/or other distressing symptoms. The suffering of patients with locomotor disorders, especially rheumatoid arthritis, was seen as the most intense -- all of these patients (13) were mentally alert and, although their pain might have responded to narcotics, these drugs had not been used for fear of habit-formation in these incurable but not directly fatal conditions. Of the 33 patients dying of cancer, less than 1/4 of these experienced moderate or severe pain; in all such cases the pain could be completely managed with strong analgesics or with narcotics.

It should be noted that this investigation was the first systematic study of these issues since Osler's 1906 review of 500 dying patients (Osler, 1906).

Exton-Smith's ground-breaking work is continued and improved upon by Hinton (Hinton, 1963). Unlike Exton-Smith's investigation, Hinton attempts a systematic somewhat more objective assessment of distress and includes a control group. The discussion section of Hinton's article contains an excellent summary of the methodologic problems in this field, and a useful description of the scant earlier literature.

The present study is a controlled investigation of the distress experienced by hospitalized dying patients. The physical discomforts (pain, incontinence, etc.), mental state (depressed, anxious, conscious, etc.), and personal background (social class, basic demographics, etc.) of 102 patients dying in a British hospital were compared with those of patients suffering serious but non-fatal illnesses. Criteria used for grading the physical and mental attributes of distress were provided in the article and appear to be generally adequate. Dying patients and their controls were visited by the research team during each week of their hospital stay. Controls and patients were matched so that they were of similar age, were admitted to hospital at roughly the same time, and had primary disease in the same organ system. All subjects were adults; no further age or sex breakdown of this population was indicated in this report.

The dying had a significantly higher incidence of unrelieved physical distress; they were also more commonly depressed and/or anxious than controls. Depression and anxiety was positively correlated with the duration and discomfort of the terminal illness. Dying patients under the age of 50 had greater physical and mental distress than did terminally ill individuals over the age of 50. Depression was more common in those aware of dying, and anxiety more common in those dying with dyspnea or having dependent children or tepid religious faith. As death approached, most patients showed increasing impairment of consciousness. Those dying patients who remained conscious to the end were more likely to suffer physical distress. Awareness of dying grew so that 3 out of 4 conscious patients spoke of the certainty or possibility of death.

Wilkes reports the findings of a 1963 Sheffield, England survey of general practitioners caring for cancer patients dying at home (Wilkes, 1965). Of the 3422 deaths from malignant disease recorded in 1963, 1890 (55%) took place at home. A sample of 20% of these domiciliary patients (N = 374) was studied; this represented a 91% completion rate of the research forms by the physicians. The precise method of sampling and data collection was not specified in this report. All descriptions of pain, distress, and standard of home care were the subjective impressions of the attending physicians. Both male and female patients were studied; age composition of the sample was not indicated except that roughly 50% of the sample was age 70 or over. 129 patients (34%) died in the summer and autumn months, and 245 (66%) died in the winter. (Presumably summer = spring and summer).

Dying at home was not always by choice. In both summer and winter, 51% required some difficult nursing, and 13% were judged by their physician to need a hospital bed which they were unable to obtain. It was concluded that "most patients are nursed well, and three-quarters have satisfactory home conditions." Such a finding may be an artifact of the sample selected. Of the entire sample, only 15% had distress lasting over 6 weeks. Of course this figure of 15% depends on the date of entry into observation and on the definition of "terminal phase" which is adopted from this article, both issues are difficult to establish with certainty. Wilkes believes that most patients wish to die at home and that they should be allowed to die at home; those few patients who can not be cared for at home, for whatever the reason, should be removed to facilities which are specially designed for terminal care.

In a 1967 publication of some exploratory research, Kastenbaum reported the results of psychological autopsies on 61 male and female dying patients at Cushing Hospital, Framingham, Massachusetts, a voluntary admission geriatric hospital (Kastenbaum, 1967). Subject ages ranged from 69 to 96; mean age at death was approximately 82 for either sex.

The results suggest that almost all of the dying geriatric patients in this sample retained, until the end, some ability to observe and interpret their situation. Observers rated 49% as having been consistently in clear contact during the terminal period; the other 51% was almost equally divided between those who were in and out of contact (26.7%) and those who were consistently in partial contact (22%). Only 2 patients were consistently out of contact during the final days of life. No relationship was found between advanced age and decreased mental status. Pain was not evaluated in these individuals.

Patients chosen for this investigation appear to be primarily those who were most "socially visible." A positive relationship was found between social visibility, as assessed by the hospital staff, and mental alertness. This sample of convenience may not be representative of the spectrum of dying geriatric patients. The author openly discussed the difficulty in achieving objectivity in this type of investigation.

Dewi Rees attempted to develop and test a simple method for recording the distress of dying patients (Dewi Rees, 1972). The factors assessed were pain, respiratory distress at rest, impairment of consciousness, awareness of dying, depression, anxiety, malaise, relief of physical distress, vomiting, bedsores, fecal incontinence, and urinary incontinence or the presence of an indwelling catheter or both. The precise method of grading these factors was not reported, and the objectivity of the hospital and home-duty nurses' daily charting of this information is difficult to assess. All subjects were followed for the duration of the terminal phase of their illness. The survey included a total of 50 patients who were residents of Llanidloes, Montgomeryshire, Wales and were dying either at home (N = 13), in a general hospital (N = 33), or in a chronic sick unit (N = 4). Their average age was 72.2 years, with a range of 41-92 years of age. All consecutive deaths in this area between November 6, 1969 and November 25, 1970 were followed.

Significant differences occurred between deaths at home and in hospital. Patients dying at home were:

a. more likely to be fully alert shortly before death ($P < .05$)

b. less likely to be suffering from vomiting, incontinence, or bedsores ($P < .001$)

c. less likely to have unrelieved physical distress ($P < .05$)

No differences in distress were noted when contrasting the type of hospital in which care was provided.

Factors contributing to patient distress were only vaguely defined in this report, and consistency and objectivity of reporting can not be guaranteed. For example, "relief of physical distress" is a rated category which overlaps with others in that the author states that "physical distress" includes "general malaise in addition to pain, dyspnoea, incontinence, vomiting, and bedsores." It could not be established if the patients dying in hospital were initially sicker, and therefore more prone to distress, than were patients who happened to or were allowed to die at home. Dewi Rees cited the work of Hinton (1963) and Exton-Smith (1961), both studies abstracted here, as models for his own investigation.

Reynolds and Kalish collected their observations on the conditions existing in a California Veterans Administration Hospital on 3 wards for chronic and terminally ill medical patients (Reynolds and Kalish, 1974). Most patients on these wards were old, bed-ridden, and many showed cognitive deterioration. Interaction between patients was minimal, and the medical and auxilliary staff displayed some reluctance to interact with these patients. Reynolds and Kalish felt that the physical facilities for these patients were "poor", and that these individuals were largely denied their sexual identity and sense of selfhood.

In a West German hospital investigation, Witzel studied 110 dying patients during the 24 hours before their deaths, and another cohort of 250 patients during the last weeks before death (Witzel, 1975). Ages ranged in both cohorts from 20 to 90+ — in both groups the mean age was about 70. The first cohort of 110 dying patients was compared to a control group of patients of the same age and sex suffering from serious but not fatal illnesses.

Of the 110 dying patients followed only during their final 24 hours, 9 died suddenly (pulmonary embolism, massive GI blood, or ruptured aortic aneurism), 16 were comatose, and 12 were mentally disturbed. The remaining 73 patients were *all* aware of time and place 24 hours before their deaths; 68 of them were well oriented up to 6 hours, 36 up to 1 hour, and 29 until 15 minutes before death. Nine patients needed analgesics to control pain. Of the total of 110 patients, 51% claimed that they expected to die; only 5% of the controls responded in this manner ($p < 0.005$).

A more extensive longitudinal survey could be made of the behaviors exhibited by the cohort of 250 patients who were followed for "some weeks" (vague) before and up to their deaths. Unfortunately, no control group was reported for this population. The important conclusions for this group of 250 were reported succinctly by the author and are reported here in full:

"These patients suffered from various physical or neuropsychiatric symptoms, including pain, dyspnoea, nausea, vomiting, persistent cough, hiccups, dysphagia, and anorexia. All had some physical symptoms. The neuropsychiatric symptoms were fear, depression, weakness, uncoordinated thinking, lack of interest, hallucinations, irritability, forgetfulness, lack of concentration and judgement, delusions, acoustic and optical illusions, and unconsciousness. More than half had some neuropsychiatric symptoms. (Note: It was not reported how effective drugs were in combatting either physical or neuropsychiatric symptoms). The physical and the neuropsychiatric symptoms appeared to influence one another. Patients with malignant tumors had more pain, while those with heart diseases suffered more from dyspnoea, and the renal patients more from nausea. The dyspnoeic patients were more freightened. The patients with a strong religious belief, and those with no faith at all, showed less fear. The young were more afraid to die than the old. There was a difference between men and women. The patients were more afraid of pain, physical distress, or chronic debility than of death itself. Firmness of religious conviction increased with deterioration of condition. Immediately before death the need for analygesic medication decreased and many patients exhibited a short increase of vitality, appreciated food again, and appeared to be generally improved." It should be noted that Witzel found that patients chronically ill with cancer went through the 5 phases described by Kübler-Ross: negation, anger, haggling, depression, and finally acceptance (Kübler-Ross, 1969).

Ballinger and Ramsey reviewed 218 cases of geriatric deaths occurring from 1971 to 1973 in a Scottish psychiatric hospital, Royal Dundee Liff Hospital (Ballinger and Ramsey, 1976). The drug treatment of this terminal group was compared with that of a control group matched on age, diagnosis, sex, and time period of hospital stay. The mean age for all individuals studied was 76.3 years. Information was gathered by retrospective review of medical charts. During the period of the study, 3% of all deaths occurring in this town occurred in this hospital.

Cases were generally sicker than controls; this is reflected in that a mean of 2.4 different drugs were received by cases on the day of death as compared to a mean of 1.7 different drugs in controls on that same day. No attempt was made to compare the relative dosages of the medications in these groups. Of the drugs prescribed, in the cases 23.6% were psychotropics whereas in controls 51% were of this nature. A higher proportion of the controls received phenothiazines and tricyclic antidepressants. When cases of sudden cardiac death (N = 20) were compared to their matched controls, no significant difference was detected in the prescription of antidepressants and phenothiazines.

Although the sample sizes were small, it was concluded that drug treatment was a common feature of a patient's last day of life in a psychiatric hospital, and that most of the drugs prescribed in this situation were administered for physical rather than mental symptoms. Severe pain in these terminal patients was rare — only 2.9% of those dying received opiates. This finding of the low occurrence of severe pain may have been due to the fact that a high percentage (75%) of these dying patients were suffering from organic psychosis. A sample such as this of terminally ill geriatric mental patients is certainly not representative of the majority of hospitalized or home dwelling dying elders. Importantly, the Ballinger and Ramsey study does not provide any evidence to support the claim in the literature that tricyclic antidepressants or phenothiazines place patients at high risk for sudden death.

Kay and his co-workers followed, for 7 years or until death, a cohort of 177 individuals aged 65 or over chosen at random from larger representative samples of elderly people living at home in Newcastle upon Tyne, England (Kay et al., 1977). All subjects were given the Weschler Adult Intelligence Scale (WAIS) or a shortened form of it. It was implied by these workers that each subject was tested more than once but the number of test administrations was not reported in their 1977 article. Also not reported was the rationale for giving some subjects the complete WAIS and giving others an abbreviated version; all subjects, regardless of type of WAIS, were analyzed collectively.

Discriminant function analysis showed that the power of the test score to predict death occurring within 2 years was not explained away by its correlations with age, sex, social class, or physical disability. Exclusion of clinically diagnosed chronic brain syndromes reduced but did not abolish the relationship found to exist between test score and outcome. Low scorers (on initial test given upon entry into study?) with scores 0-19 were at significantly higher risk of dying in a 2 year period than were higher scorers. The authors report "that it is the rate of change rather than the actual level of performance at any one time which is more important." It is not clear if the authors have this rate of change information on the cohort under investigation. The conclusion is that "the ascertainment of impaired cognitive functioning has important applications in the assessment of prognosis and in the planning of care of elderly people."

This small sample does not appear to be representative of a free-living elderly population. Details of the composition of this cohort are reported elsewhere (Savage et al., 1973), but on the basis of the present article, this sample appears to be psychiatrically disadvantaged. Thirteen people suffering from dementia were found in this sample of 177. Within the 2 year period in which initial WAIS scores predicted survivalship, 26 people died — 15 scoring low and 11 scoring above the cutoff score of 19. The death certificates indicated that cerebral dysfunction from various causes had been present in 7 of the 15 low scorers and in only 3 of the 11 high scorers. No brains were examined post-mortem, but it is entirely possible that the patients with impaired cognitive fucntion as assessed by the WAIS were individuals whose health as well as intellectual powers were already compromised at the onset of the study by generalized cerebrovascular disease. Low WAIS scores in this investigation may be markers for cerebrovascular disease and perhaps were not, as the authors contended, indicators of decreased survival potential in physically healthy people.

"How" — associated issues

An investigation by Spitzer and Folta was aimed at discovering how efficiently hospital personnel could cope with both expected and unexpected patient deaths (Spitzer and Folta, 1964). Thirty-eight deaths occurring over a 3-month period in 4 Seattle, Washington hospitals were studied as to the coping style of the staff in reaction to these deaths. All data were gathered via personal interviews with involved hospital staff and family members. These interviews were conducted as close as possible to the time of death of the index cases. The deaths studied were in all age groups. Details about the sample and its method of selection were not provided in this article.

Twenty-five of these deaths had been anticipated; 13 were unanticipated. Hospital routine operated smoothly when anticipated deaths occurred; unanticipated deaths resulted in serious breakdown of usual hospital procedures. The manner in which these data were analyzed was not reported.

Heasman and Lipworth tried to assess the frequency of autopsies and to ascertain whether there existed a high order of agreement in Britain between clinical and post-mortem diagnoses of cause of death (Heasman & Lipworth, 1966). This survey was conducted during 1959 in 75 hospitals of the British National Health Service. Each hospital attempted to achieve 100% post-mortem examination rate for the period of the study. The study was conducted only during the summer months -- a period in which 14% less deaths occurred than in the winter. These methodologic issues of course will weaken the validity and generalizeability of any findings.

Of a total of 14,617 deaths (all ages) observed during the study period, 65% were followed by autopsy. Under non-study conditions, it is impossible to tell how many of these deaths would have been autopsied. In hospitals where autopsies were not performed after every death, they were performed most frequently when the clinician felt uncertain of his diagnosis. The proportion of autopsies performed fell with increasing age of the patients; however, where the diagnosis was uncertain, age made no difference.

In a 1964 paper, Hinton gives a good summary of the literature on this topic up to 1964 and he reviews his own work in the field (Hinton, 1964). He calls for more organized, intensive research into the issue of the distress of the dying in the hope that such work will replace the scattered clinical impressions that pervade this literature. Of special interest is his call for research on the amount of pain reduction accomplished with certain maintenance regimens as well as on their potential for lengthening the life of a terminal patient.

Kalish provides a short list of neglected but important topics within the death, dying, and bereavement field (Kalish, 1969). He asks that clinicians who deal with the terminally ill and their families, take up these issues and conduct systematic investigations to provide answers to the questions posed. This is an interesting challenge to the research community; Kalish identifies many areas of the literature which were not adequately covered in 1969 and still remain unresolved. An example of such an unresolved issue would be the relationship between pain intensity and attitudes toward one's own death.

CONCLUSION

The literature on the circumstances of death in the elderly is in an early, inconclusive state. What is known is largely due to the fascination of British researchers with this problem; the quickest of glances at the bibliography will convince one of the British domination of this field. Where death occurs is the best resolved of all the questions posed; whether or not it is for the best or not, the elders in industrialized nations tend to die in hospitals and not in their own homes. As for when the elderly die, in the advanced western and eastern societies, death is more common during the cold months than the warm. Personal timetables for death are often cited but good scientific evidence for these phenomena is scant.

The questions collected under the rubic of "how" our elders die, are difficult, as yet unsolved, issues. Many methodologic problems have stood in the way of answers. The objective assessment and comparison of human suffering is not an easy task. Also, in studying these issues, it is very difficult to know at what point in an individuals life cycle the terminal phase really begins. Of the 8 "how of death" points of interest, 3 can not be answered on the basis of systematic scientific research:

1. Was a physician present at the time of death?

2. Does the attending medical staff have information on the prior illnesses of dying patients?

3. How frequently and under what circumstances are autopsies performed on these patients? (Heasman & Lipworth's 1966 work is too methodologically unsound to provide an answer here).

Knoweldge on the remaining 5 topics is, as indicated in the text, in various states of disaray. Popular myth often also helps to impede research on these issues. For example, popular opinion wrongly holds that cancer deaths are horrible and that heart attacks result in quick, peaceful demise.

This is a young field to which American researchers have not yet become committed. It is clear that the dying geriatric patient is a poorly understood individual. Modern medicine has a responsibility to all patients and it can not fully serve these individuals until the where, when, and particularly the how of their demise is better understood.

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Abstracts for National Institute on Aging - Dr. Jacob Brody

BORTNICHAK -

A. Journal article abstracts

1. Kastenbaum, R., Mishara, B.L.: Premature death and self-injurious behavior in old age. Geriatrics, 26:7, July 1971, pp. 71-81.

The work of these authors was prompted by the observation that, in general, "old people die alone"; the dying elder, unlike the emerging infant, is in a societally imposed isolation and the circumstances of his death go largely unnoticed. Suicide among the elderly has been amply documented and continues to be a significant problem. Other premature deaths in this age group, although not frank suicides, if subjected to "psychological autopsy" can often be attributed to more subtle behaviors that are either consciously or unconsciously self-injurious.*

These authors undertook an exploratory investigation of this phenomenon of self-injurious behaviors among 64 male and 142 female geriatric inpatients in a Michigan State mental hospital. All patients were hospitalized on the basis of chronic, irreversible medical problems; no subject was determined to be psychotic. For a period of 7 days, attendants were asked to look for and record any self-destructive behavior in these patients. These behaviors ranged from "bumping into things (while walking)" to "eating foreign objects". No control group was utilized, and the definition of "self-injurious" behavior was vague, at best. The only result worth reporting here is that (not surprisingly!) these individuals did, indeed, exhibit the behaviors that the research team was interested in. A major problem with this work is that all of these reported behaviors were seen by the authors to be potentially life-threatening— they could equally well be perfectly "normal", harmless actions.

This article contains many good ideas for future research; the original research reported must be viewed only as "ground breaking" in a previously unexplored field which deserves and demands careful, controlled research.

*Note: The psychological autopsy is an intensive multidisciplinary case approach introduced by Schneidman and Farberow to investigate instances in which the cause of death was difficult to determine by traditional means.[1,2]

1. Litman, R.E., Curphey, T.J., Shneidman, E.S., etal.: Investigations of equivocal suicides. JAMA 184:924-929, 1963.

2. Shneidman, E.S.: Sample investigations of equivocal suicidal deaths. In: The Cry for Help. Edited by N.L. Farberow and E.S. Shneidman, New York, McGraw-Hill, Inc., 1965.

3. Fischer, H.K., Olin, B.M.: Man's determination of his time of illness or death--anniversary reactions and emotional deadlines. Geriatrics 26:7, pp. 89-94, July 1971.

A collection of 10 case reports and a variety of historical anecdotes demonstrating Hilgard's classical anniversary reaction and/or the operation of emotionally invested deadlines. Such intrapsychic stress can predispose individuals to fatal illnesses; some patients may harbor accurate, self-fulfilling expectations about the time or circumstances of their own death. These patterns are part of the conscious and unconscious will of the individual, they may be indicators of psychopathology, and they can often be favorably influenced with psychotherapy.

3. Fischer, H.K., Olin, B.M.: Psychogenic determination of time of illness or death by anniversary reactions and emotional deadline. Psychosomatics 13:3, May-June 1972, pp. 170-3.

A loosely organized, unconvincing collection of case histories demonstrating the psychogenic time patterns and factors contributing to man's illness onset and death. In all, 9 cases are presented--6 examples of "emotionally-invested deadlines", 2 reports illustrating Hilgard's "classical anniversary reaction", and 1 history demonstrating a subject's unrepressions and stress on the annual anniversary of a heart attack which happened to also occur on a religious holiday. Fischer and Olin's argument for the importance of personal psychogenic determinants of time of death is further supported by anecdotes from the non-medical literature on the timing of the deaths of American historical figures.

4. Alderson, M.: Relationship between month of birth and month of death in the elderly. British Journal of Preventive & Social Medicine 29:151-156, 1975.

This was an analysis of mortality data of persons aged 65+ in England and Wales for 1972 (N = 255,164) in order to examine the relationship between month of birth and month of death. To remove any seasonal effect in either the month of birth or month of death, each individual was regarded as dying in a specific month relative to his month of birth, ranging from 5 months before (-5) to 6 months after (+6). Using Edwards test for seasonality, it was possible to test for any cyclic trend in this distribution for the 12 classes (months of birth, month before and after birth). For persons 75 and over in each of 8 subgroups (4 marital status categories for each sex) there was a consistent trend deaths with an excess in the birth month and in the following 3 months. Compared to expected rates, death rates preceeding the birth month were low. The excess observed was of the order of only 1% of all deaths in the year, but it was statistically significant for each subgroup. No pattern emerged for deaths in individuals aged 65-74.

The author hypothesized that birthdays in 75+ year olds in some unknown subtle way undermines the morale and therefore the health of these individuals. Such an explanation is purely conjectural at this time. Why doesn't a similar lowering of morale occur in the 65 year old? The data was not analyzed by cause of death.

5. Roger, J.H.: An explanation for the observed increase in mortality after a birthday in people over 75 years old. Br. J. of Preventive & Social Med. 31: 62-64, 1977.

This is a statistical critique of the analysis on the previously cited, Alderson (1975) data. Roger believes that Alderson's numerically small, although statistically significant, relationship between birth and death month in 75+ year olds is an artifact by the sampling procedure employed. The population at risk of dying within any given year can vary due to two main opposing effects. As the age-specific mortality increases with age, the number of deaths will tend to increase. However, as the population at risk decreases, due to both earlier mortality and a smaller cohort as defined by year of birth, the actual number of deaths will tend to decrease. Roger contents that if Alderson took account of these subtle, progressive month by month changes in the population at risk, his observed birth-death month relationship would disappear.

6. Feinleib, M., Fabsity, R.: Do biorhythms influence day of death? (letter), New England J. Med. 298:1153, #20, May 18, 1978.

This brief report relates the results of a statistical analysis of 960 deaths (both sexes and all ages) and their relationship to day of death personal biorhythms (23 day and 28 day cycles). No correlation was detected; abnormally high death rates do not occur on critical days in the biorhythm cycle.

7. Rees, J.R.: Accidental hypothermia. The Lancet i:556-559, March 15, 1958.

This was a small (4 patient) clinical study of hypothermia in the elderly due to cold home exposure. The primary condition represented in this sample of convenience were senility, myocardial infarction, acute paraplegia, and diabetic coma. Three of these 4 patients died, and in each case where death occurred, hypothermia complicated the clinical picture and significantly contributed to the demise of the patient. Slow warning of the hypothermic patient is indicated. Rees advances the view that accidental home environment induced hypothermia may be a serious and underdiagnosed condition in the elderly which significantly contributes to the mortality of this age group.

8. Emslie - Smith, D.: Accidental hypothermia - a common condition with a pathognomic electrocardiogram. The Lancet ii:492-495, September 6, 1958.

Another small clinical study of hypothermia in Britain due to cold home exposure. Eight elderly patients developed hypothermia which precipitated their deaths. Electrocardiograhic confirmation of hypothermia is discussed.

9. Duguid, H., Simpson, R.G. and Stowers, J.M.: Accidental hypothermia. The Lancet ii:1213-1219, December 2, 1961.

A series of 23 British cases of accidental hypothermia is described. All patients (except one aged 56) were elderly (aged 65+) and all cases arose during the winter and came to the hospital. In only 6 patients did the hypothermic state arise "spontaneously"--without excessive exposure to cold. In all other instances the hypothermia was caused by cold home environments. Only 7 out of the 23 patients survived their hypothermia. Again, the importance of hypothermia and its contribution to mortality in the elderly is pointed out.

10. Taylor, G.: The problem of hypothermia in the elderly. Practitioner 193:761-767, 1964.

This article contains a collection of case reports and summarizes what is known about hypothermia and its contribution to mortality in the aged. Taylor believes hypothermia is often accompanied by undernutrition and that this combination is especially dangerous. He estimates (on the basis of unreported information) that each year in Britain between 1 and 5 old people (ages?) in every community of 2,500 die from diseases associated with hypothermia. If this figure is measured against a population of 50 million, it indicates a death rate from hypothermia each winter in Britain of between 20,000 and 100,000. The author believes hypothermia deserves to be more often indicated on death certificates, and he feels that this condition is usually undetected by clinicians because the ordinary clinical thermometer does not register temperatures below 95°F (35°C). Hypothermia is defined (in 1964) as a rectal temperature below 32.2°C.

11. Fox, R.H., Woodward, P.M., et al.: Body temperatures in the elderly - a national study of physiological, social and environmental conditions. British Medical Journal, pp. 200-206, Jan. 27, 1973.

Although not specifically a study of the relationship between hypothermia and mortality, this large scale cross sectional survey does establish the magnitude of the problem of cold exposure in British men and women over the age of 65 and living in their own homes during the winter of 1972. Subjects for this national survey were selected at random by a systematic probability sampling procedure. Physiological measurements included mouth, hand, and urine temperature assessments. For each subject, the investigators also collected basic sociodemographic information, attitudes toward the cold, and information on utilization of available medical and social services. The general medical condition of these respondents was not reported. Regrettably, non-response rates were not indicated in this report.

Most of the homes visited were cold with room temperatures below the minimum recommended by the Department of Health. Deep body temperatures below 35.5°C were found in 10% of those studied, and the difference between the skin and core temperature was also reduced in this group. Such individuals are at risk of developing hypothermia since they show evidence of some degree of thermoregulatory failure. These investigators feel that hypothermia is a major health problem in Britain's elderly and, they offer their data in support of Taylor's contention (Taylor, G., 1964) that hypothermia contributes significantly to the mortality of the elderly.

12. Macpherson, R.K., Ofner, F. and Welch, J.A.: Effect of the prevailing air temperature on mortality. *British J. of Preventive and Social Med.* 21: 17-21, 1967.

Macpherson et al., studied the Lidcombe Hospital, Sydney, Australia population during the year 1963 and attempted to detect patterns between mortality and daily ambient air temperature (3 p.m. reading). All subjects were chronically ill adults; this study was not limited to the geriatric age group.

Temperature effects began to be noticed in patients from age 70 on; these effects were most pronounced in the oldest individuals. The effect of successive hot days appeared to be cumulative; such a cumulative pattern was not found for cold days. The authors' concluded that overall, "in the relatively mild climatic conditions prevailing, the effect of unfavorable temperatures was small, possibly having some part in 6.3% of all deaths."

This study could have been more informative if the mode of death and if the physiologic temperature - coping ability of patients had been noted. Also, a single temperature reading per day, in a single location, may not have been sufficient. References from this article lead to a vast literature correlating weather with death (about 80 articles between 1930 and 1967).

13. Momiyama, M.: Biometeorological study of the seasonal variation of mortality in Japan and other countries on the seasonal disease calendar. Int. J. Biometeor. 12:377-93, #4, 1968.

This is a detailed compilation of morbidity and mortality statistics from 1900 to 1960 for various diseases in Japan, the U.S., Egypt, the U.K., France, Germany and Denmark. Monthly differences in disease frequencies for each disease were noted and this prompted the author to prepare a seasonal disease calendar which summarizes these trends by country and by period. Such a calendar represents deaths in all age groups; this technique can of course also be used in plotting deaths specifically in the elderly.

Social conditions, more so than seasonal and climatic changes, must be involved to explain the trends noted. In Japan, the U.S. and in the highly industrialized European nations, the mortality peak has shifted from the summer to the winter for most diseases. This is attributed to the sophistication and general availability of medical services and the high baseline level of public health in these countries. In such countries summer diseases (such as enteritis food poisonings) have been arrested but winter pneumonia ailments are still quite prevalent. In these industrialized nations, increasingly in winter from all kinds of diseases, including those which formerly raged in summer. Of course, the age structure of a population must be considered in explaining these patterns. The author's prediction for industrial nations is that as medical and public health services advance, variation in mortality will be deseasonalized. In emerging nations, a high summer mortality and typical seasonal disease distributions are noted. Momiyama states that the threat of winter cold and its effects is a technologically surmountable problem.

References from this article may be of interest; this list of references has been appended.

Int. J. Biometeor. Vol 12, #4, 1968
pp 377-93

The author's seasonal disease calendars indicate that the mortality rate ha erally been on the downcurve relative to the progress of industrialization,an deaths come increasingly in winter from all kinds of diseases,including those formerly raged in summer.

In the so-called advanced countries, summer diseases have been more or le rested, but winter ailments still remain as prevalent as ever. In these coun it may be said, all but senile diseases have been successfully controlled ow the development of efficient drugs, the improvement of medical services and w conditions, the higher standards of living and so forth.In the newly industria countries, on the other hand, many maladies are still prevalent in summer.

Finally, the challenging problem ahead of the advanced nations is to carry effective campaign against the concentration of mortality of senile diseases i ter. At the present stage of medical development, cold in winter appears to insurmountable natural factor. But this is simply a temporary phenomenon whi and will be eliminated sooner or later, with advances in medical and public services in our society,as was pointed out in the chapter on signs of deseaso seen in the variation of mortality in USA.

Some of the most important problems which I want to make the subject of tensive investigation from an international view point are:
(a) reconsideration of winter concentration theory;
(b) deseasonality of mortality and
(c) effects of artificial climate on mortality.

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14. Lake, B.: Morbid conditions at death in old men. J. Chronic Dis. 21:761-779, #11, April 1969.

This is an analysis of all autopsies in men of age 70 and older at Lidcombe Hospital, Sydney, Australia from July 1, 1963 to June 30, 1967--a total of 713 autopsy records. The major goal of the study was to document patterns in co-morbid conditions. 50% of the population at risk came to autopsy. Lidcombe Hospital served its community as both a hospital and as a home for the socially or physically incapacitated aged ill. All cases included in this study died within this combined hospital-home facility.

The only section of this report of interest here are the findings dealing with seasonal effects. Despite the fact that the daily hospital and home populations remained almost constant over each 12 month period, winter death rates were twice that of the summer. The deaths in spring were next highest, and those in autumn next lowest. This seasonal pattern was most pronounced in the 80+ age group. The average monthly relative humidity was not correlated with the average monthly incidence of death. The only lesion which was statistically related to season was acute tracheobronchitis.

15. Feinleib, M., Rogot, E. and Sturrock, P.A.: Solar activity and mortality in the United States. International J. of Epidemiology 4:227-229, #3, Sept. 1975.

This study was a response to a series of earlier Soviet studies which stated that geomagnetic storms were the cause of an observed increase in mortality from MI in several cities within the U.S.S.R. The present authors tested the validity of an association of solar activity with daily mortality from cardiovascular disorders in the entire U.S. for the period 1964 to 1966, and the association with monthly mortality for the 8 year period 1964 to 1971. The total number of deaths occurring each day in the U.S. for 1964-1966 was obtained from tapes provided by the National Center for Health Statistics. Mortality statistics on a monthly basis were also obtained from the National Center for Health Statistics for the period 1964-1971; solar activity data were also available for this 8 year period. Daily solar activity was measured by the index of geomagnetic activity, Ap, as reported by the World Data Center.

The American data did not support the association observed by the Soviets; if any relationship between solar activity and U.S. mortality (coronary heart disease, stroke and/or total deaths) did exist, it was a slightly inverse association. These American investigators took into account that there could be a lag between occurrence of a geomagnetic disturbance and increased mortality risk; even after accounting for a possible 30 day lag in the effect, no significant relationship was observed. It was concluded that the Russian findings can perhaps be explained by other environmental factors such as weather and pollution conditions. All references cited in this article were in Russian and dated from 1964 to 1969.

16. Biersteker, K., and Evendijk, J.E.: Ozone temperature and mortality in Rotterdam in the Summer of 1974 and 1975. Environmental Research 12:214-217, #2, October 1976.

This Dutch study was an attempt to observe the effect of high photochemical oxidant air concentrations on daily mortality in urban Rotterdam. Heat waves rarely effect this city, but the scattered appearance of such days (86°F or more) was noted during 1975 and the combined effect of heat and oxidant pollution could be investigated for that year. Daily mortality was followed during July and August of 1974 and 1975. The daily temperature maxima were provided by the Royal Meteorological Institute for the center of Rotterdam; daily oxidant concentration maximas were similarly centrally collected and reported. Somewhat haphazardly, the authors' surveyed the national death statistics for this same period.

It was determined that high temperature alone was correlated with a significant rise in mortality; ozone elevations alone had no discernable effect on mortality in 1974, and that, if any effect existed in 1975, it could not be separated from the effect of temperature. The rise in mortality experience occurred mainly in the population group aged 70+. Total daily mortality in the Netherlands also bore this out and indicated that the increased death rate occurred in both small and large municipalities. The conclusion from this national data that urbanization did not play a role in exacerbating the death rate is unfounded because age specific structure of the population at risk in these various-sized municipalities was not taken into account.

17. Sakamoto-Momiyama, M.: Changes in the seasonality of human mortality - a medico-geographical study. Soc. Sci. & Med. 12:29-42, March 1978.

This report is a review and restatement of this author's earlier (1968) work (previously cited) on seasonal disease calendars. The only additional observation in this 1978 article is the author's view that along with the creation of heated indoor artificial environments in industrialized nations comes both deseasonality of overall mortality and the introduction of the complex problem of mortality due to man-made pollution.

what country where

18. Aitken-Swan, J.: Nursing the late cancer patient at home - the family's impressions. The Practitioner 183:64-69, 1959.

The author sought to study the circumstances surrounding the deaths of cancer patients by collecting the recollections of their relatives concerning the terminal weeks. Any relatives who could provide information appear to have been used. This was a sample of convenience of the relatives of 200 cancer patients (ages unspecified) who died during the study year either at home or in any medical facility within the service area of the Christie Hospital, Manchester, England. It should be emphasized that all information collected reflect the unverified, subjective impressions of bereaved relatives. Information provided by these respondents fall into 5 general categories:

1. Demand for admission of the deceased to hospital or a chronic care facility.
2. Home nursing circumstances.
3. Impressions of deceased's medical care.
4. Impressions of deceased's pain and sedation.
5. Other impressions.

Several results emerged. 85% of these families felt that terminal care was adequate. Only 14% of this group of 200 dying cancer patients were admitted to a hospital or a chronic care facility. An additional 15% wanted admission to a hospital or other medical care institution but could not gain admission. One third of those families home-nursing their dying member spoke of severe strain; the remaining two thirds did not indicate any problems with the nursing experience. 48% of the relatives thought that their patients had less pain than they had expected or considered that pain was adequately relieved. In 18%, a qualified statement was made. In 20% of cases relatives described severe pain which was unrelieved by the measures taken. The overall impression obtained was that, in general, these relatives felt that the general practitioner in charge of care "did everything that was possible", and they were most appreciative to these physicians. Recall that this was a sample of convenience and that perhaps only satisfied consumers of the health care system were selected to participate in this survey.

19. Exton-Smith, A.N.: Terminal illness in the aged. The Lancet, pp. 305-308, August 5, 1961.

This study is based on 220 terminally ill patients (80 men and 140 women), all of whom were inpatients in the geriatric unit of Whittington Hospital, London at the time of their death. Ages ranged from 60 to 101; the average age was 80. The pain and general bodily distress attributed to the terminal illness was assessed as was the circumstances of death, the patient's mental state, and the patient's awareness of his condition and surroundings. The personal observations of the attending nursing staff was relied upon for this information; no consistent questionnaire protocol was followed--the nurses merely recorded any information volunteered by these patients. The grading of severity of pain was an especially subjective determination. ("Did pain respond to aspirin or was a stronger analgesic necessary?").

Only 40% of these patients (88 individuals) were unconscious for 3 hours or more before death (comatose), another 34 died suddenly, often in their sleep, the remainder (98) died while awake and lucid. At least 25% of all patients realized they were dying. Most of the patients who died while lucid were calm at the hour of their death. How much the medication schedules of these patients influenced all of this is impossible to determine from this article.

A total of 21.3% of these patients complained of at least moderate pain and/or other distressing symptoms. The suffering of patients with locomotor disorders, especially rheumatoid arthritis, was seen as the most intense--all of these patients (13) were mentally alert and, although their pain might have responded to narcotics, these drugs had not been used for fear of habit-formation in these incurable but not directly fatal conditions. Of the 33 patients dying of cancer, less than 1/4 of these experienced moderate or severe pain; in all such cases the pain could be completely managed with strong analgesics or with narcotics.

It should be noted that this investigation was the first systematic study of these issues since Osler's 1906 review of 500 dying patients. (Osler, W.: Science and Immortality, London, 1906).

20. Hinton, J.M.: The physical and mental distress of the dying. Quarterly J. of Medicine 32:1-21, #125, Jan. 1963.

The discussion section of this article contains an excellent summary of the methodological problems in this field, and a useful description of the scant earlier literature.

The present study is a controlled investigation of the distress experienced by hospitalized dying patients. The physical discomforts (pain, incontinence, etc.), mental state (depressed, anxious, conscious, etc.), and personal background (social class, basic demographics, etc.) of 102 patients dying in a British hospital were compared with those of patients suffering serious but non-fatal illnesses. Criteria used for grading the physical and mental attributes of distress were provided in the article and appear to be generally adequate. Dying patients and their controls were visited by the research team during each week of their hospital stay. Controls and patients were matched so that they were of similar age, were admitted to hospital at roughly the same time, and had primary disease in the same organ system. All subjects were adults; no further age or sex breakdown of this population was indicated in this report.

The dying had a significantly higher incidence of unrelieved physical distress; they were also more commonly depressed and/or anxious than controls. Depression and anxiety was positively correlated with the duration and discomfort of the terminal illness. Dying patients under the age of 50 had greater physical and mental distress than did terminally ill individuals over the age of 50. Depression was more common in those aware of dying, and anxiety more common in those dying with dyspnea or having dependent children or tepid religious faith. As death approached, most patients showed increasing impairment of consciousness. Those dying patients who remained conscious to the end were more likely to suffer physical distress. Awareness of dying grew so that 3 out of 4 conscious patients spoke of the certainty or possibility of death.

21. Hinton, J.M.: Problems in the care of the dying. Editorial in J. chron. Dis. 17:201-5, 1964.

Hinton gives a good summary of the literature on this topic up to 1964 and he reviews his own work in the field. (Hinton's work has been abstracted in these pages). He calls for more organized, intensive research into the issue of the distress of the dying in the hope that such work will replace the scattered clinical impressions that pervade this literature. Of special interest is his call for research on the amount of pain reduction accomplished with certain maintenance regimens as well as on their potential for lenghening the life of a terminal patient.

22. Wilkes, E.: Terminal cancer at home. Lancet 1:799-801, April 10, 1965.

This is a report of the findings of the 1963 Sheffield, England survey of general practitioners caring for cancer patients dying at home. Of the 3422 deaths from malignant disease recorded in 1963, 1890 (55%) took place at home. A sample of 20% of these domiciliary patients (N = 374) was studied; this represented a 91% completion rate of the research forms by the physicians. The precise method of sampling and data collection was not specified in this report. All descriptions of pain, distress, and standard of home care were the subjective impressions of the attending physicians. Both male and female patients were studied; age composition of the sample was not indicated except that roughly 50% of the sample was age 70 or over. 129 patients (34%) died in the summer and autumn months, and 245 (66%) died in the winter. (Presumably summer = spring and summer).

Dying at home was not always by choice. In both summer and winter, 51% required some difficult nursing, and 13% were judged by their physician to need a hospital bed which they were unable to obtain. It was concluded that "most patients are nursed well, and three-quarters have satisfactory home conditions." Such a finding may be an artifact of the sample selected. Of the entire sample, only 15% had distress lasting over 6 weeks. Of course this figure of 15% depends on the date of entry into observation and on the definition of "terminal phase" which is adopted—from this article, both issues are difficult to establish with certainty. Wilkes believes that most patients wish to die at home and that they should be allowed to die at home; those few patients who can not be cared for at home, for whatever the reason, should be removed to facilities which are specially designed for terminal care.

23. Kastenbaum, R.: The mental life of dying geriatric patients. Gerontologist 7:97-100, June 1967.

The author considered this work to be exploratory research. Reported here are the results of psychological autopsies on 61 male and female dying patients at Cushing Hospital, Framingham, Massachusetts, a voluntary admission geriatric hospital. Subject ages ranged from 69 to 96; mean age at death was approximately 82 for either sex. This is an early report of an ongoing study -- a follow-up paper to this one could not be located.

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The results suggest that almost all of the dying geriatric patients in this sample retained until the end some ability to observe and interpret their situation. Observers rated 49% as having been consistently in clear contact during the terminal period; the other 51% was almost equally divided between those who were in and out of contact (26%) and those who were consistently in partial contact (22%). Only 2 patients were consistenly out of contact during the final days of life. No relationship was found between advanced age and decreased mental status. Pain was not evaluated in these individuals.

Patients chosen for this investigation appear to be primarily those who were most "socially visible." A positive relationship was found between socia visibility, as assessed by the hospital staff, and mental alertness. This sample of convenience may not be representative of the spectrum of dying geriatric patients. The author openly discussed the difficulty in achieving objectivity in this type of investigation.

24. Kalish, R.A.: The practicing physician and death research. Medical Times 97:211-220, #1, Jan. 1969.

Kalish provides a short list of neglected but important topics within the death, dying, and bereavement field. He asks that clinicians, who deal with the terminally ill and their families, take up these issues and conduct systematic investigations to provide answers to the questions posed. This is an interesting challenge to the research community; Kalish identifies many areas of the literature which were not adequately covered in 1969 and still remain unresolved. An example of such an unresolved issue would be the relationship between pain intensity and attitudes toward one's own death.

25. Howell, T.H.: Some terminal aspects of disease in old age — a clinical study of 300 patients. J. of the American Geriatrics Society 17:1034-1038, #11, 1969.

The terminal stages of life were observed in 300 patients, ages 65 to 104, at Queen's Hospital, Croydon, England. The clinical syndromes found to be associated with the final deterioration were classified into 4 groups:

1. ischaemia (affected 31% of sample)
2. toxaemia (in 15%)
3. unexpected complications (in 25%)
4. incomplete or unsatisfactory diagnosis (in 29%)

No autopsies were performed; this was solely a study of terminal symptomatology. The "true" degree of suffering of these individuals, and the representativeness of this sample of convenience were impossible to assess from this report.

26. Dewi Rees, W.: The distress of dying. British Medical Journal 3:105-7, #818, July 8, 1972.

The author describes a simple method of recording the distress of dying patients. The factors assessed were pain, respiratory distress at rest, impairment of consciousness, awareness of dying, depression, anxiety, malaise, relief of physical distress, vomiting, bedsores, fecal incontinence, and urinary incontinence or the presence of an indwelling catheter or both. The precise method of grading these factors was not reported, and the objectivity of the hospital and home-duty nurses' daily charting of this information is difficult to assess. All subjects were followed for the duration of the terminal phase of their illness. The survey included a total of 50 patients who were residents of Flanidloes, Montgomeryshire, Wales and were dying either at home (N = 13), in a general hospital (N = 33), or in a chronic sick unit (N = 4). Their average ages was 72.2 years, with a range of 41-92 years of age. All consecutive deaths in this area between November 6, 1969 and November 25, 1970 were followed.

Significant differences occurred between deaths at home and in hospital. Patients dying at home were:

a. more likely to be fully alert shortly before death $(p < .05)$

b. less likely to be suffering from vomiting, incontinence, or bedsores $(p < .001)$

c. less likely to have unrelieved physical distress $(p < .05)$

No differences in distress were noted when contrasting the type of hospital in which care was provided.

Factors contributing to patient distress were only vaguely defined in this report, and consistency and objectivity of reporting cannot be guaranteed. For example, "reflief of physical distress" is a rated category which overlaps with others in that the author states that "physical distress" includes "general malaise in addition to pain, dyspnoea, incontinence, vomiting, and bedsores." It could not be established if the patients dying in hospitals were initially sicker, and therefore more prone to distress, than were patients who happened to or were allowed to die at home. Dewi Rees cites the work of Hinton (1963) and Exton-Smith (1961) both studies abstracted here, as models for his own investigation.

27. Agate, J.: Care of the dying in geriatric departments. Lancet i:364-366, February 17, 1973.

This article is not a research report; it is rather Dr. Agate's views on the optimal hospital and/or home environment in which dying geriatric patients should be nursed. It contains suggestions for improving terminal care facilities in Great Britain. Agate uses British national statistics to confirm the frequently cited observation that deaths are more often occurring in hospitals and less often in the homes of patients. Also, he offers his own impressions in support of the notion that most deaths in a hospital geriatric department are either sudden and effortless or are a relatively painless slow, gentle decline. Generally during these "slow" deaths, there are a few hours of terminal bronchopneumonia, in which the patient is usually comatose. He attributes the ease of most geriatric deaths to the "mental deterioration and lack of insight so common amongst very elderly people." This last point is especially open to question. In those hospitalized cases for which the dying is not so peaceful, Agate feels that not enough attention is paid to the proper control of terminal symptoms.

28. Walker, M.: The last hour before death. Amer. J. of Nursing 73:1592-93, #9, Sept. 1973.

This is a collection of the clinical impressions of nurse Walker about the peaceful passing of most of the patients she has attended. Few patients, in her experience, die in pain or discomfort. Conscious patients seem to know when they are about to die. Walker mentions an unreferenced study of hospital deaths which reports that most deaths occur between 11:00 p.m. and 7:00 a.m.; few deaths occur during daytime working hours. Walker speculates that perhaps the hustle and bustle of daytime hospital activities gives even dangerously ill patients something to take interest in and to live for. This is solely a report of one nurse's ideas.

29. Neuringer, C. and Harris, R.M.: The perception of the passage of time among death-involved hospital patients. *Life-Threatening Behavior* *4*:240-254, #4, Winter 1974.

This was a fairly well designed and executed study of unfortunately small sample size. These investigators attempted to evaluate the extent of the relationship between death involvement and temporal orientation among hospitalized suicidal, terminal, geriatrically ill, and normal individuals. Each of these 4 groups was comprised of 15 subjects; if matching occurred on any variable, it was not reported. It can be however established that these subjects were, unfortunately, widely disparate on the factors of age and on length of stay in the hospital. The individuals in the non-suicidal groups were carefully subjected to pre-study admission screening for suicidal impulses so that these groups would not be contaminated on this factor. Perceptions of the passage of time was evaluated by a behavioral estimation of elapsed time, and by a survey of opinions concerning the pass of time.

Suicidal patients, closely followed by the geriatrically ill, overestimated time intervals to a much greater extent than did the normal and terminal patients. The suicidal subjects expressed a great deal of impulsiveness and described themselves as feeling miserable to a much greater degree than did the other groups. It was not at all clear is such warped time perception was truly a precipitating causal agent of self-destructive behavior, or if it was an associated but non-causal factor. Of all the groups, the terminally ill patients reported that they felt the greatest amount of time pressure--time was "flying by them"; this finding is in agreement with reports in the earlier literature.

30. Reynolds, D.K., and Kalish, R.A.: The social ecology of dying--observations of wards for the terminally ill. Hospital and Community Psychiatry 25:147-152, #3, March 1974.

This is a collection of clinical impressions; the authors collected their notes on the conditions existing in a California Veterans Administration Hospital on 3 wards for chronic and terminally ill medical patients. Most patients on these wards were old, bed-ridden, and many showed cognitive deterioration. Interaction between patients was minimal, and the medical and auxilliary staff displayed some reluctance to interact with these patients. Reynolds and Kalish felt that the physical facilities for these patients were "poor" and that these individuals were largely denied their sexual identity and sense of selfhood.

31. Witzel, L.: Behavior of the dying patient. British Medical Journal 2: 81-2, April 12, 1975.

In this West German hospital investigation, 110 dying patients were studied during the 24 hours before their deaths and 250 patients were followed during the last weeks before death. Ages ranged in both cohorts from 20 to 90+--in both groups the mean age was about 70. The first cohort of 110 dying patients was compared to a control group of patients of the same age and sex suffering from serious but not fatal illnesses.

Of the 110 dying patients followed only during their final 24 hours, 9 died suddenly (pulmonary embolism, massive GI bleed, or ruptured aortic aneurism), 16 were comatose, and 12 were mentally disturbed. The remaining 73 patients were all aware of time and place 24 hours before their deaths; 68 of them were well oriented up to 6 hours, 36 up to 1 hour and 29 until 15 minutes before death. Nine patients needed analgesics to control pain. Of the total of 110 patients, 51% claimed that they expected to die; only 5% of the controls responded in this manner. ($p < 0.005$).

A more extensive longitudinal survey could be made of the behaviors exhibited by the cohort of 250 patients who were followed for "some weeks" (vague) before and up to their deaths. Unfortunately, no control group was reported for this population. The important conclusions for this group of 250 were reported succinctly by the author and are reported here in full:

"These patients suffered from various physical or neuropsychiatric symptoms, including pain, dyspnoea, nausea, vomiting, persistent cough, hiccups, dysphagia, and anorexia. All had some physical symptoms. The neuropsychiatric symptoms were fear, depression, weakness, uncoordinated thinking, lack of interest, hallucinations, irritability, forgetfulness, lack of concentration and judgement, delusions, acoustic and optical illusions, and unconsciousness. More than half had some neuropsychiatric symptomes. (Note: It was not reported how effective drugs were in combatting either physical or neuropsychiatric symptoms.) The physical and the neuropsychiatric symptoms appeared to influence one another. Patients with malignant tumors had more pain, while those with heart diseases suffered more from dyspnoea, and the renal patients more from nausea. The dyspnoeic patients were more freightened. The patients with a strong religious belief, and those with no faith at all, showed less fear. The young were more afraid to die than the old. There was difference between men and women. The patients were more afraid of pain, physical distress, or chronic debility than of death itself. Firmness of religious conviction increased with deterioration of condition. Immediately before death the need for analgesic medication decreased and many patients exhibited a short increase of vitality, appreciated food again, and appeared to be generally improved. It should be noted that Witzel found that patients chronically ill with cancer went through the 5 phases described by Kübler-Ross (1969): negation, anger, haggling, depression and finally acceptance.

32. Ballinger, B.R. and Ramsey, A.C.: Death and drug treatment in a psychiatric hospital. Gerontology 22:220-226, #3, 1976.

Ballinger and Ramsey reviewed 218 cases of geriatric deaths occurring from 1971 to 1973 in a Scottish psychiatric hospital, Royal Dundee Liff Hospital. The drug treatment of this terminal group was compared with that of a control group matched on age, diagnosis, sex, and time period of hospital stay. The mean age for all individuals studied was 76.3 years. Information was gathered by retrospective review of medical charts. During the period of the study, 3% of all deaths occurring in this town occurred in this hospital.

Cases were generally sicker than controls; this is reflected in that a mean of 2.4 different drugs were received by cases on the day of death as compared to a mean of 1.7 different drugs in controls on that same day. No attempt was made to compare the relative dosages of the medications in these groups. Of the drugs prescribed, in the cases 23.6% were psychotropics whereas in controls 51% were of this nature. A higher proportion of the controls received phenothiazines and tricyclic antidepressants. When cases of sudden cardiac death (N = 20) were compared to their matched controls, no significant difference was detected in the prescription of antidepressants and phenothiazines.

Although the sample sizes were small, it was concluded that drug treatment was a common feature of a patient's last day of life in a psychiatric hospital, and that most of the drugs prescribed in this situation were administered for physical rather than mental symptoms. Severe pain in these terminal patients was rare--only 2.9% of those dying received opiates. This finding of the low occurrence of severe pain may have been due to the fact that a high percentage (75%) of these dying patients were suffering from organic psychosis. A sample such as this of terminally ill geriatric mental patients is most certainly not representative of the majority of hospitalized or home dwelling dying elders. Importantly, the Ballinger and Ramsey study does not provide any evidence to support the claim in the literature that tricyclic antidepressants or phenothiazines place patients at high risk for sudden deat

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*The controversy about the adverse effects of these psychotropic drugs is rep in:

1. Moir, et al., Lancet ii:561, 1972.
2. Lestman and Koenig. Archs. Gen. Psychiat. 18:137, 1968.

3. Moore & Book. Psychiat. Q. 44:389, 1970.

4. Boston Collaborative Drug Surveillance Programme. Lancet i:529, 1972.

5. Peele and van Loetzan: Am. J. Psychiat. 130:306, 1973.

33. Kay, D.W.K., Britton, P.G., Bergmann, K., and Foster, E.M.: Cognitive function and length of survival in elderly subjects living at home. Australian and New Zealand J. of Psychiatry II:113-117, #2, June 1977.

These authors followed, for 7 years or until death, a cohort of 177 individuals age[illegible] or over chosen at random from larger representative samples of elderly people living at home in Newcastle upon Tyne, England. All subjects were given the Weschler Adult Intelligence Scale (WAIS) or a shortened form of it. It was implied that each subject was tested more than once but the number of test administrations was not reported in the article. Also not reported was the rationale for giving some subjects the complete WAIS and giving others an abbreviated version; all subjects, regardless of type of WAIS, were analyzed collectively.

Discriminant function analysis showed that the power of the test to predict death occurring within 2 years was not explained away by its correlation with age, sex, social class, or physical disability. Exclusion of clinically diagnosed chronic brain syndromes reduced but did not abolish the relationship found to exist between test score and outcome. Low scores (on initial test given upon entry into study?) with scores 0-19 were at significantly higher risk of dying in a 2 year period than were higher scorers. The authors report "that it is the rate of change rather than the actual level of performance at any one time which is more important." It is not clear if the authors have this rate of change information on the cohort under investigation. The conclusion is that "the ascertainment of impaired cognitive functioning has important applications in the assessment of prognosis and in the planning of care of elderly people."

This small sample does not appear to be representative of a free-living elderly population. Details of the composition of this cohort are reported elsewhere, but on the basis of the present article, this sample appears to be psychiatrically disadvantaged.* Thirteen people suffering from dementia were found in this sample of 177. Within the 2 year period in which initial WAIS scores predicted survivalship, 26 people died--15 scoring low and 11 scoring above the cutoff score of 19. The death certificates indicated that cerebral dysfunction from various causes had been present in 7 of the 15 low scorers and in only 3 of the 11 high scorers. No brains were examined post-mortem, but it is entirely possible that the patients with impaired cognitive function as assessed by the WAIS were individuals whose health as well as intellectual powers were already compromised at the onset of the study by generalized cerebrovascular disease. Low WAIS scores in this investigation may be markers for cerebrovascular disease and perhaps were not, as the authors contented, indicators of decreased survival potential in physically healthy people.

34. Spitzer, S.P. and Folta, J.R.: Death in the hospital—a problem for stud

Nursing Forum 3:85-92, #4, 1964.

This investigation was aimed at discovering how efficiently hospital personnel could cope with both expected and unexpected patient deaths. Thir deaths occurring over a 3-month period in 4 Seattle, Washington hospit were studied as to the coping style of the staff in reaction to these deaths. All data were gathered via personal interviews with involved hospital staff and family members. These interviews were conducted as close as possible to the time of death of the index cases. The deaths studied were in all age groups. Details about the sample and its method of selection were not provided in this article.

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*Savage, R.D., Britton, P.G., Bolton, N. and Hall, E.H.: Intellectual functic in the aged. ? London, 1973.

Twenty-five of these deaths had been anticipated; 13 were unanticipated. Hospital routine operated smoothly when anticipated deaths occurred; unanticipated deaths resulted in serious breakdown of usual hospital procedures. The manner in which these data were analyzed was not reported.

35. Pike, L.A.: Comparison of mortality in the elderly at home and in a welfare home. Journal of the Royal College of General Practitioners 22:648-650, #122, Sept. 1972.

This 6-year comparison of mortality in age-sex matched elderly populations in a Birmingham, England welfare home and in a Birmingham area general practice showed statistically significant longer survival in those outside the welfare home. The total welfare home population consisted of 62 individuals (48 females and 14 males); a similar number of subjects were drawn from the general community. Admission to the welfare home was for a variety of medicosocial or purely social reasons; all individuals in the study were believed to be of similar socioeconomic background. It was not clear how socioeconomic class was determined. All deaths that occurred were attributable to common chronic geriatric causes.

The reason(s) for the noted mortality differences could not be determined. Pike speculates that the nursing home individuals were either initially sicker and/or less physically active in the welfare home environment and therefore more obese than the individuals living in their own homes in the community. Both hypotheses should be easily testable using the available medical records.

neither idea was investigated in this study.

36. Cordle, F. and Tyroler, H.A.: The use of hospital medical records for epidemiologic research. (I) Differences in hospital utilization and in-hospital mortality by age-race-sex-place of residence and socioeconomic status in a defined community population. Med. Care 12:596-610, #7, July 1974.

Although predominantly aimed at describing differences in hospital admission rates, this large scale cross-sectional evaluative research also provided some good information on black-white differences in hospital mortality experience. All admissions to and deaths occurring in the hospitals serving the biracial population of Charleston County, South Carolina were surveyed for the year 1963. Each of these hospitals served as a teaching hospital for the Medical College of South Carolina; the entire population at risk for hospitalization during 1963 was well defined and numbered 215,000. Effort was made to include Charleston County residents who happened to be hospitalized in neighboring county hospitals. In-hospital mortality of individuals aged 35-64 was investigated. Whites in this age group were 4.5 times more likely to be admitted to a hospital than were blacks in the same age group. However, blacks, once admitted to the hospital, were 7 times more likely to die in the hospital than were whites. The authors' speculated that blacks who gained hospital admission were more seriously ill than their white counterparts. The admission rate for whites in these Charleston Hospitals compared favorably with that for whites reported in other U.S. hospitals; the overall hospital admission rate for blacks in the U.S. was 1.4 times that for blacks in Charleston.

B. Book and Periodical Abstracts

1. Care of the Dying - Proceedings of a National Symposium held on November 29, 1972.

Department of Health and Social Security; Reports on Health and Social Subjects, #5, London, Her Majesty's Stationery Office, 1973, 92 pp. (Note: Also reported in: Br. Med. J. i:29-44, Jan. 6, 1973.

This symposium covered most aspects of terminal care. Those sections of the report which focuses on aspects of present interest are abstracted here.

pp. 1-6: Terminal Care by Surgeon Rear Admiral J.M. Holford.

This introductory paper delivered by Dr. Holford attempts to document "where" people die in Britain. In 1965, 38% of all deaths (all ages) occurred at home and 50% occurred in non-psychiatric hospitals. The remaining 12% of deaths were left unspecified as to location in this report. Contrast these 1965 figures to 1970 rates for total deaths—33.5% at home and 54% in non-psychiatric hospitals. (Remainder again unsepcified). There is clearly a trend away from home terminal care and to hospital care. If only cancer deaths are considered, the same relationship holds. The data presented here were unreferenced.

pp. 30-34: Paper by Professor E. Wilkes

Dr. Wilkes reports results from his cancer survey in Sheffield, England (unreferenced). These results support Dr. Holford's previously cited observation that the trend is to die in the hospital and not at home. It is also noted that the majority of patients (age unspecified) observed dying at home do no experience significant pain or distress. Only 10 to 15% had unfullfilled medical needs. (See: Wilkes - Lancet, April 10, 1965; reviewed here under "Journal Abstracts").

pp. 65-69: Paper by B.J. McNulty, S.R.N.

The observations cited were based on work with 784 dying patients having some contact with St. Christopher's Hospice, London, during the period Oct. 1969-Oct. 1972. This work documents rather well both the problems and the great benefits to patient, family, community, and medical staff resulting when the dying are allowed to expire in their own homes. Of the 784 patients followed, 86 were able to die at home by their own wish. The ages and method of selection of the individuals comprising the sample were unfortunately not indicated. The number of patients able to die at home is largely dependent on the effective operation of hospital-based domiciliary services such as the one evaluated in this survey.

2. Heasman, M.A. and Lipworth, L.: Accuracy of Certification of Cause of Death; General Register Office, Studies on Medical and Population Subjects, #20, London, Her Majesty's Stationery Office, 1966.

The major purpose of this investigation was to ascertain whether there existed a high order of agreement between clinical and post-mortem diagnoses of cause of death. This survey was conducted during 1959 in 75 hospitals of the British National Health Service. Each hospital attempted to achieve 100% post mortem examination rate for the period of the study. The study was conducted only during the summer months--a period in which 14% less deaths occurred than in the winter. These methodologic issues of course will weaken the validity and generalizability of any findings. We are mainly interested in those results dealing with the frequency of post-mortem examination.

Of a total of 14,617 deaths observed during the study period, 65% were followed by autopsy. In hospitals where autopsies were not routinely performed after every death, they were performed most frequently when the clinician felt uncertain of his diagnosis. The proportion of autopsies performed fell with increasing age of the patients; however, where the diagnosis was uncertain, age made no difference.

3. Glyn Hughs, H.L.: *Peace at the Last - A Survey of Terminal Care in the United Kingdom*; Report to the Calouste Gulbenkian Foundation, London, 1960; 63 pp.

This was an ambitious project; it was designed to document "all the problems of terminal care for persons with a restricted expectation of life." ("restricted expectation of life" = 12 months or less). The survey was carried out between November 1957 and December 1958. Survey design was based on the geographical pattern of the British National Health Service. Data were assessed using mail questionnaires returned by physicians, hospital statistics, and visits by the research staff to a cross-section of every type of establishment (including homes of patients) in which terminal care might occur. Although the sampling and data collection seemed quite sound, not enough detailed information was provided in the report to reach a final decision on the methods of this survey and on the generalizeability of its results. Mortality data were not restricted to any age category; most death rates reported were by cause of death irrespective of patient age.

The result of most interest at present was that concerning "where" people die in Britain. In 1956, 40% of all deaths occurred in National Health Service hospitals. Of the remaining 60% which occurred outside these hospitals, 82.4% occurred in the patient's own home. Therefore, nearly 50% of the total number of deaths took place at home. Mortality data were tabulated in 6 categories of death site - N.H.S. hospitals, medical institutions other than N.H.S. institutions, person's own home, mental health establishments, and "elsewhere". This "elsewhere" category accounted for only about 4.8% of all deaths, and it includes such sites as hotels, boarding houses, public places, and on the street.

The remainder of this report was concerned with comparisons of the facilities for terminal care provided by various types of institutions, regional demand for and problems in obtaining hospital beds for terminal patients, the role of the family during terminal illness, and the reactions of patients upon learning the seriousness of their condition. The problems of pain management and changes in mood and consciousness during terminal illness were mentioned in passing and were not among the issues systematically researched in this project.

4. Brim, O.G., Jr., Freeman, H.E., Levine, S. and Scotch, N.A.: *The Dying Patient*; Russell Sage Foundation, New York, 1970; 380 pp.

Although not solely limited to the problems of dying *geriatric* patients, this volume contains a wealth of information on this topic. In addition, the author's provide an excellent annotated bibliography. The concluding chapter of the book, "Dying and its Dilemmas as a Field of Research", by Diana Crane, serves as a fine overview of the field at present and indicates useful direction for future research.

The opening chapter of this book is the only section directly relevant to the issues presently of interest to the NIA. A summary of the contents of this chapter follows.

Chapter 1: When, Why, and Where People Die by Monroe Lerner

Lerner collected data on the circumstances of death in the United States. He traces the changes in lifespan which have occurred through the years and he comments on the "major killers" and the lives they claim. Of most interes is his review of the sparse information on "where" Americans die. Lerner sta that "where people die -- in a hospital or other institution, at home, or in a public place -- has been a relatively neglected aspect of mortality statistics in this country during the past few years." The national statistics for 1949 show that in that year 49.5% of all deaths occurred in a hospital or other health care facility; by 1958 this figure rose to 60.9%. National data is lacking for years after 1958, but tabulations compiled since then by a variety of states and cities confirm the continuence of this trend toward in-hospital dying. In general, these data show deaths at home to be dropping (for New York City, from 31.4% in 1955 to 24.2% in 1967.), deaths in hospitals and other medical institutions to be rising (for New York City from 65.9% in 1955 to 73.1% in 1967), and deaths on the street and in all other places to be remaining constant since the 1950's at about 3% (for New York City, from 2.8% in 1955 to 2.6% in 1967). These general trends hold fairly well across all segments of the U.S. population, but data are given on how these overall patterns vary somewhat according to geographic region, race, and disease. [illegible]

5. Lewis-Faning, E.: A Comparative Study of the Seasonal Incidence of Mortality in England and Wales and in the United States. Medical Research Council, Great Britain, Special Report #239, 1940; pp. 1-69.

This is a thorough survey of national mortality data in Wales, England, and the United States. Except in the case of bronchitis and pneumonia, age breakdowns of deaths by specific cause is unfortunately not indicated in this report.

C. Bibliography

In addition to the literature abstracted and critiqued in these pages, the following materials may be of interest. This bibliography contains literature written in English and in other languages.

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2. Poteet, G.H.: Death and Dying - A Bibliography (1950-1974). The Whitston Publishing Company, Troy, New York, 1976.

3. Phillips, D.: Dying as a Form of Social Behavior. Unpublished Doctoral Dissertation, Princeton University, 1969. (Note: Concerns the relationship of death to birthdays).

4. Marie Curie Foundation: Report of a National Survey Concerning Patients with Cancer Nursed at Home; Joint National Cancer Survey Committee, Marie Curie Memorial, London, 1952.

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COHORT DEATH RATES FROM HEART DISEASE: PAST AND FUTURE TRENDS[1]

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ABSTRACT

Death rates from heart disease (HD) indicate that each successive birth cohort in the United States tends to experience lower age-specific mortality. We examined cohort mortality from HD at ages 40 and over for white men and women in the U.S. between 1945 to 1975 employing a log-linear model in which mortality rates are a function of age. For each successive birth cohort from 1886-1890 to 1906-1910, female HD mortality rates exhibit a continous, parallel decline which shows no sign of abating in recent years. Among men, cohort HD mortality rates were increasing prior to 1965; since 1965, there has been a reversal of prior trends, i.e. each successive cohort has shown a decrease in HD mortality rates. None of the various hypotheses put forward to explain the recent decline in HD mortality provides a cogent explanation for the differential effects in men and women. Based on recent cohort trends, mortality declines should continue for both sexes into the future.

Introduction

While cardiovascular disease remains the number one killer in the United States, unprecedented declines in mortality due to heart disease (HD) occurred in the post-war period from 1945 to 1975. These changes are apparent in rates for males and females of the white and non-white races at every age (1).

Taking the extremes, for the 40-44 year age group, white male HD mortality rates declined 26 percent, while white female rates declined 53 percent from 1945 to 1975. At ages 85 and over, white male rates declined only 3 percent, and white female rates declined almost 14 percent. The progress was primarily among females and males under age 60, though age-specific rates declined for every age group of whites over the thirty-year period in a more or less monotonic fashion.

The suspected reasons for these decreasing rates are numerous (2) and include declines in broadly defined environmental risk factors as well as improvements in prevention, treatment, and control of HD and its precursors. All of these factors have contributed to reduce the risk of HD mortality, especially in the non-elderly. This paper does not attempt to assess the relative importance of any particular factor nor asserts that other factors not mentioned and perhaps not yet investigated exerted greater effects. Instead we examine time series data on cohort mortality, which are essentially the results of these numerous impacts, to see how selected cohorts have been affected and what future HD mortality rates may be anticipated. Specifically, this paper examines the trends in death rates from HD over the period 1945-1975 for white male and female cohorts and projects future declines in cardiovascular mortality rates based on a log-linear model and existing age-specific trends. This model does not consider causal or explanatory variables other than age; instead, it documents and quantifies the differences in observed and predicted rates for males and females based solely on the age-specific death rates for the different cohorts examined.

Methodology

The trends and variations we examine are found in U.S. Vital Statistics on HD deaths by age over time, allowing us to follow five-year cohorts. The descriptive form of the hypothesis we are examining can be stated as follows:

> Since 1945, younger cohorts of white males and females are healthier, as measured by lower age-specific HD mortality, at every age than older cohorts. In terms of regression results, the intercepts should be lower for each younger cohort and slopes should be less steep, reflecting lower risk at each age.

The data used are the age-specific death rates for diseases of heart taken from the the U.S. Vital Statistics for the years 1945, 1950, 1955, 1960 1965, 1970, and 1975, published by the National Center for Health Statistics. These years span the fifth, sixth, seventh, and eighth revisions of the International Classification of Diseases and Causes of Death, Adapted (ICDA), a period in which the broad rubric of diseases of the heart was relatively unaffected by changes in the ICDA.

Age-specific data for the cohorts of whites are utilized. In this way we hope to avoid possible bias in the nonwhite data introduced by changing percentages of the races, e.g. Negro, Indian, and Oriental, or by reporting differences by race which may have varied over the period 1945-75 that do not reflect declines in risk of HD mortality. Male and female rates are examined separately for each cohort by the five-year age groups from age 40 to age 85 and over. The analyses compare the birth cohorts 1886-90, 1891-1895, 1896-1900, 1901-1905, and 1906-1910.

Since death rates from HD tend to rise exponentially with age (Figures 1 and 2), we have used the geometric equation: $Y=ae^{bX}$, where Y is the age-specific death rate from HD and X is age. The log-linear transformation of this, $\text{Ln } Y=\text{Ln } a + bX$, yields a straight line plot of the data as shown in Figures 3 and 4. This model provides the basis for estimating values for the death rates for white male and female cohorts, though the number of estimating points is small. Thus, only the five cohorts of males and females born between 1886 and 1910 are modelled. Comparing the a and b coefficients among the cohorts allows us to identify rates of change and to test our hypothesis of successive improvement by cohort in risk of death from HD. Comparing the actual age-specific death rates with the points estimated by the linear model also provides a means of predicting the future course of age-specific HD mortality rates.

Thus, the methodology relies on log-linear regression techniques and readily available national mortality data to test the hypothesis of decreasing risk by cohort. The cohort is the basic unit of analysis; white males and females age 40 and over in 1945 and every five years to 1975 are analyzed by five-year age groups. The quantitative analysis is used to show demographic trends in HD mortality.

Results

The results are presented in terms of the hypothesis that younger cohorts had a successively reduced HD mortality rate. Figures 1 and 2 depicting the mortality rates for white men and women for the period 1945-75 show the geometric growth of the age-specific incidence of death from HD by cohort.

For white females, the R^2 (coefficient of determination) values of the equations are over .99 for the five cohorts examined. The slopes are all essentially equal (b=0.101) with successively lower intercepts for younger cohorts indicating parallel trends at reduced levels. These results suggest that the age-specific incidence of HD is lower for each succeeding cohort of white women born between 1886 and 1910. Death rates for more recent cohorts (born as recently as 1935) show a continuation of this pattern of successively lower age-specific mortality from HD. Thus for white females, the hypothesis of declining cohort risks of HD holds true.

The HD death rate per 100,000 for white female population could be projected using the prediction equations for these cohorts. Since the HD rates predicted for 1975 exceeded the actual values of HD rates in 1975, this suggests an overestimation of future HD mortality using these predicted values and greater future declines in HD mortality rates for white women than might be expected.

For white males, the cohort results of the log-linear regression model seem to contradict the cross-sectional age-specific data. The younger cohorts have successively lower intercepts, but steeper slopes (b coefficients) than the older cohorts, suggesting that projections to future years would place the age-specific death rates of the younger cohorts at successively higher levels than older cohorts. We can see from the mortality rates of recent years that this did not occur. Since 1965, the cohort rates have been progressively diverging downward from the predicted regression line (Figures 4).

Therefore, we decided to separate the data into two segments of observations, 1945-60 and 1965-75, based on the analysis of residual errors from the initial model fitting, supported by observation concerning the downturn in HD death rates which occurred in the mid 1960's (2). While the original R^2 values ranged from .999 to .988, the new split period models had values all above .992 and slopes that clearly reflected the dramatic change in HD mortality trends which occurred between 1960 and 1965.

The equations for the five cohorts over the period before 1965 indicate, through higher b values for each younger cohort, increasing age-specific mortality for each successive cohort; the post-1965 model shows almost the opposite effect. For the post-1965 period, the slopes get progressively flatter (smaller) over the four oldest cohorts, indicating declining cohort mortality over the decade and beyond. The youngest cohort (1906-10) has a slope value between those of the 1891-95 and 1896-1900 cohorts but starting at a lower intercept. Except for the 85 and over group which is an aggregate of all surviving members of past cohorts, even the low predicted values from this post-1965 model exceed the actual values for these cohorts in 1975, indicating a continued decline in age-specific rates over time. The plot of the two models produces a dramatic "mirror" effect, shown in Figure 5, resulting from shift that occurred for white male rates between 1960 and 1965.

For the youngest cohort analyzed (1906-1910), the HD rate in 1975 was 1,568 per 100,000. Yet the 1945-75 model predicts age 65-69 mortality rate to be 1,841 per 100,000 in 1975 while the pre-1965 model predicts a rate of 3,402 per 100,000 which is over twice the rate predicted using the post-1965 model (1,605 per 100,000). Thus, there is tremendous variation in the predicted HD rates, and even that predicted by the most recent period tends to overestimate actual behavior of the cohort.

The limited experience of white cohorts since World War II shows clearly that age-specific HD mortality rates in both men and women have fallen steadily. Especially since 1965, every cohort has experienced lower HD mortality at the same age than the cohort before it. The cohorts born after 1910 can be expected to continue to experience reduced risks of HD mortality.

The progression of change, with the largest percentage decline between 1945 and 1975 having occurred at the youngest ages (40-44) and the smallest change at the oldest (85 and over) for both males and females, is quite clear. In every age group except the open-ended (85 and over) group, the mortality decline between 1970 and 1975 was significantly greater than it had been between 1965 and 1970. These findings are consistent with the proposed hypothesis that since 1945 the younger cohorts have been experiencing and will continue to experience lower HD mortality at a given age than the cohorts which preceded them.

Discussion

In this paper, we analyze the U.S. white population over age 40 to see consequences of the cohort differences in habits and risk factors in the form of declining HD cohort mortality. Our hypothesis is true for white female cohorts born after 1886 and generally true of white males, though between 1945 and 1965 there was a tendency for younger male cohorts to be at higher risk than preceding cohorts of white males. The factors responsible for these trends are not clear (3).

Three observations deserve emphasis:

1. Since 1965, every age cohort has had lower HD mortality than the previous cohort. The linear model based on age-specific cohort data from 1945-1975 tends to fit extremely well for all white female cohorts, but overestimates the incidence of HD deaths for the younger white male cohorts because of the rise

in rates through 1960 and rapid drop in rates after 1965. The recent trends suggest a continued drop in these age-specific rates for both males and females.

2. The declines in the female and male rates have been most rapid at the younger ages, as measured by the percentage change in the rates for white females and males. This suggests that U.S. life expectancy will continue to increase since heart disease is responsible for almost half of the deaths in the elderly. Further, female longevity will probably continue to outdistance that of men since female rates have declined most rapidly.

3. The discontinuity seen in the male rates before 1965, when combined with analyses using the linear model, suggests that the difference between the observed white male mortality and predicted white male mortality is substantially greater than previously thought. It is probable that rapid declines seen recently in male rates will continue. The white female rates have exhibited a continuous, parallel cohort by cohort decline whose consistency suggests an ongoing trend into the future and whose rates exceeds even the male decline since 1965.

The implications are clear. White men and women are experiencing real declines in risk of HD mortality. Female rates are falling faster than male rates at every age, suggesting a continued increase in number of older women, especially widows, relative to men in the elderly population of the U.S. The medical profession and society will have to deal with more older people and their attendant frailty and dependency. Long-term care institutions, especially nursing homes, can expect to be fully occupied by people who, on average, are older than those institutionalized at present. Certain economic and social conditions may be exacerbated because of the longevity increases of those living on limited incomes, especially with Government support.

Cardiovascular epidemiologists will continue to be called upon to explain the factors responsible for the decline and the sex differences in the HD mortality. Many hypotheses have been put forward for the recent decline in HD mortality. Such factors as improvement in the primary risk factors leading to a decrease in the incidence of heart attacks have been suggested by some; improvements in medical care and treatment programs as well as the effects of more widespread public health education have been mentioned by others. A careful consideration, however, of the differences in trends in the cohort analysis between the male and female patterns indicates that whatever the cause of the HD death rate decline has been, it has operated somewhat differently among men and women. Among women it appears that the decline has been going on for several decades when HD is considered as a total group. For men, heart disease mortality was increasing for the individual cohorts up to the early 1960's, then underwent a turnaround by 1965. Although the recent decline may be due to similar factors which have been operating in women prior to the 1960's, these do not explain what was going on in men during this earlier period. At the present time there are no simple explanations for why men and women have been differing in their cohort patterns of HD mortality.

Besides awareness of the differences in trends between men and women, more attention needs to be given in future analyses to the change in demographic mix of the population in the sense that certain socioeconomic and ethnic groups which are known to vary in incidence of HD may be found in different proportions in each new cohort of the U.S. population. This is true of the mix of immigrants versus first and second generation Americans. The differences often cited for Japanese in this regard illustrate the point. Once the demographic mix is examined, it may become more apparent which factors are most responsible for true changes in the risk of HD mortality. With such knowledge, steps in prevention and control of HD can increase in effectiveness.

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Figure 1

Age-Specific Death Rate For Disease of Heart For Five White Female Birth Cohorts

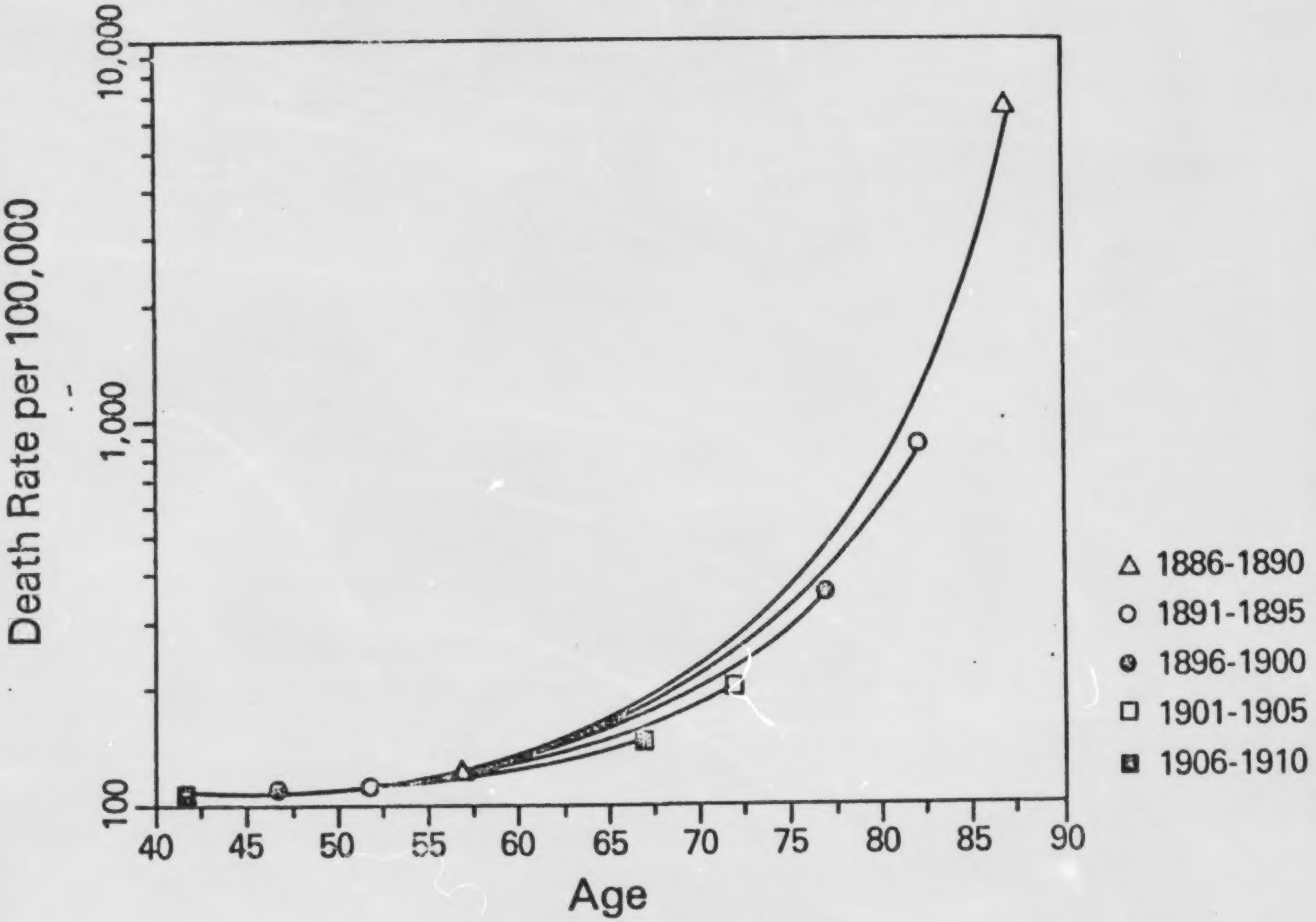


Figure 2

Age-Specific Death Rate For Disease of Heart For Five White Male Birth Cohorts

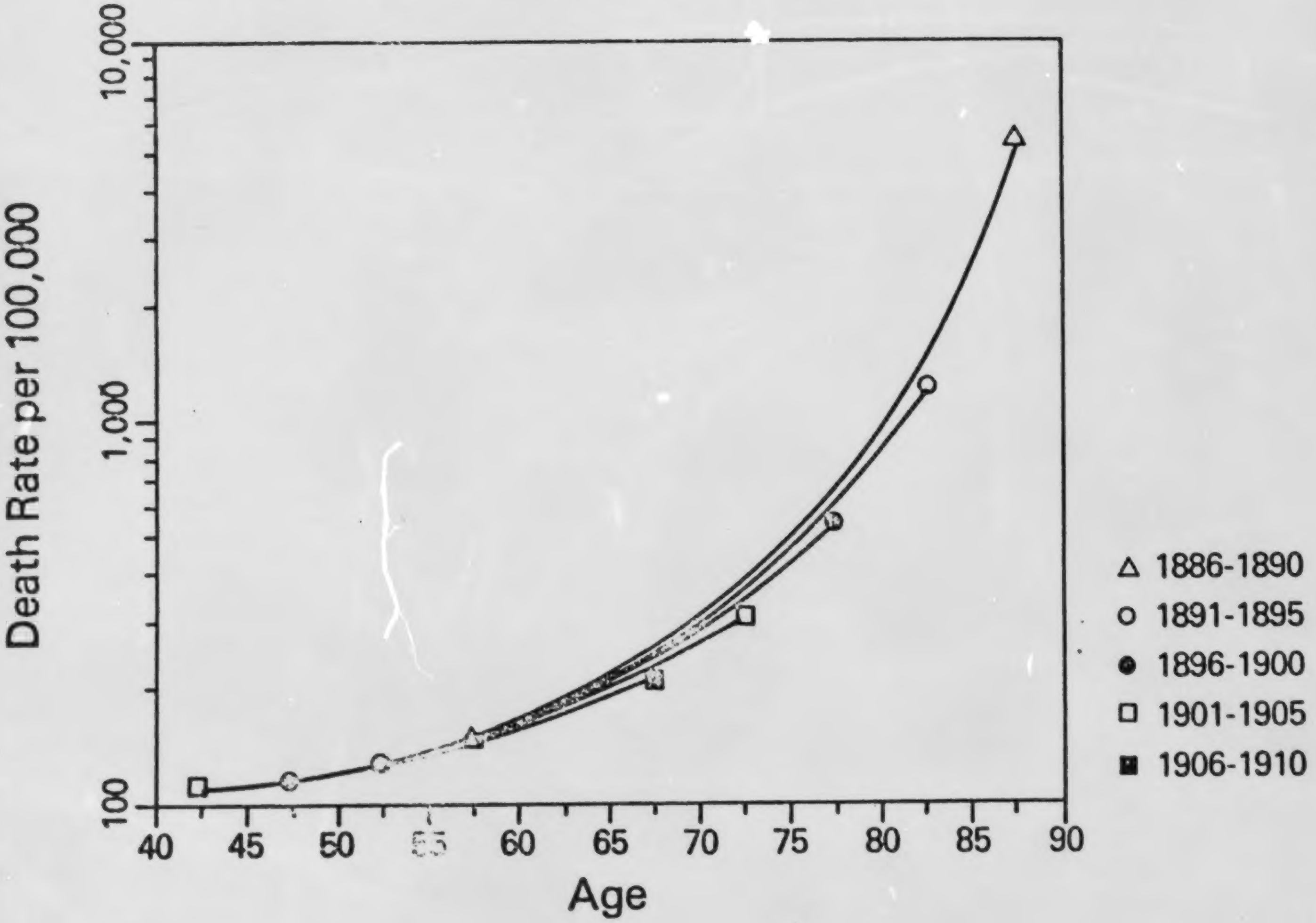


Figure 3

Loglinear Regression Model of Age-Specific Death Rate For Disease of Heart For Five White Female Birth Cohorts

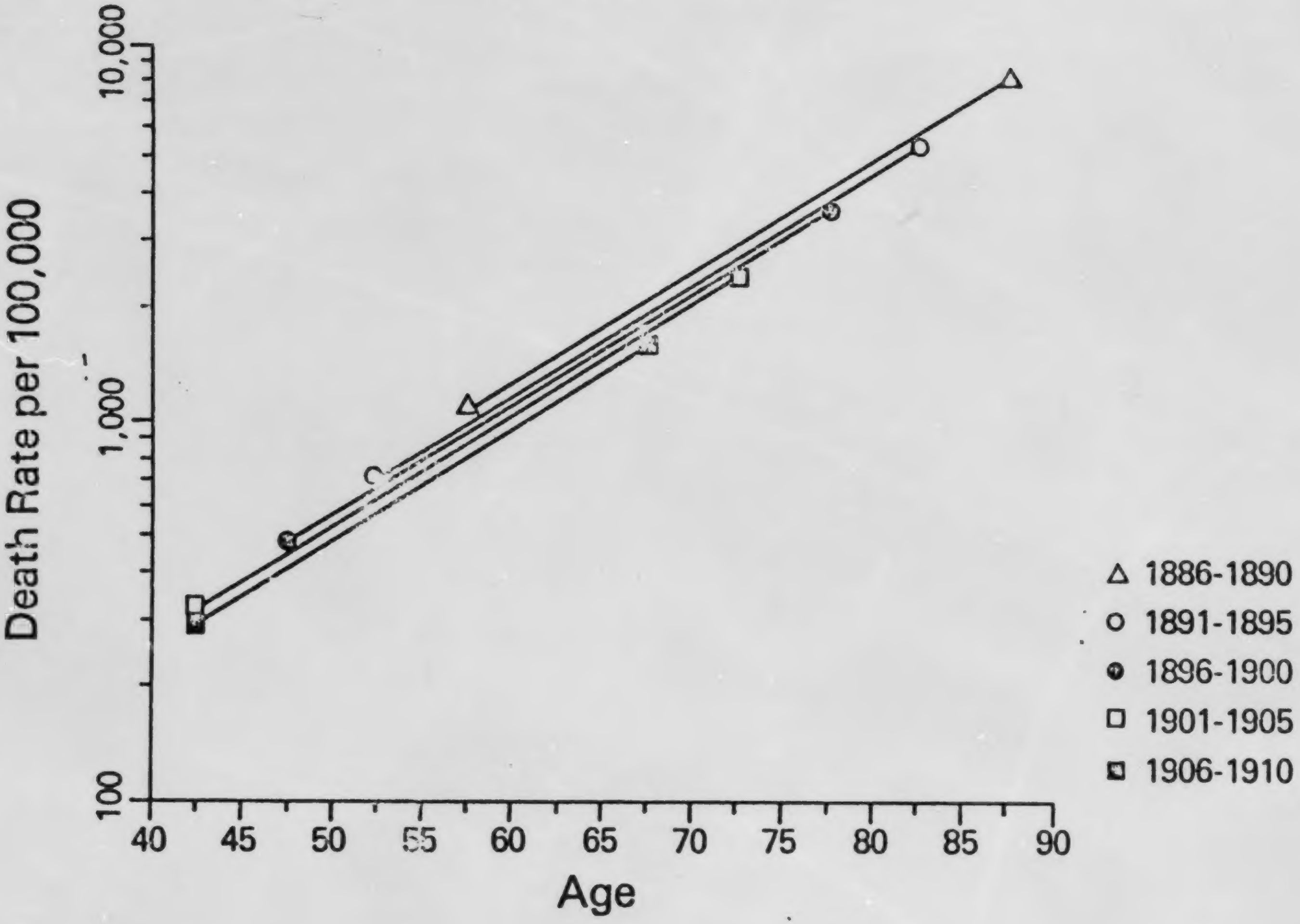


Figure 4

Loglinear Regression Model of Age-Specific Death Rate For Disease of Heart For Five White Male Birth Cohorts

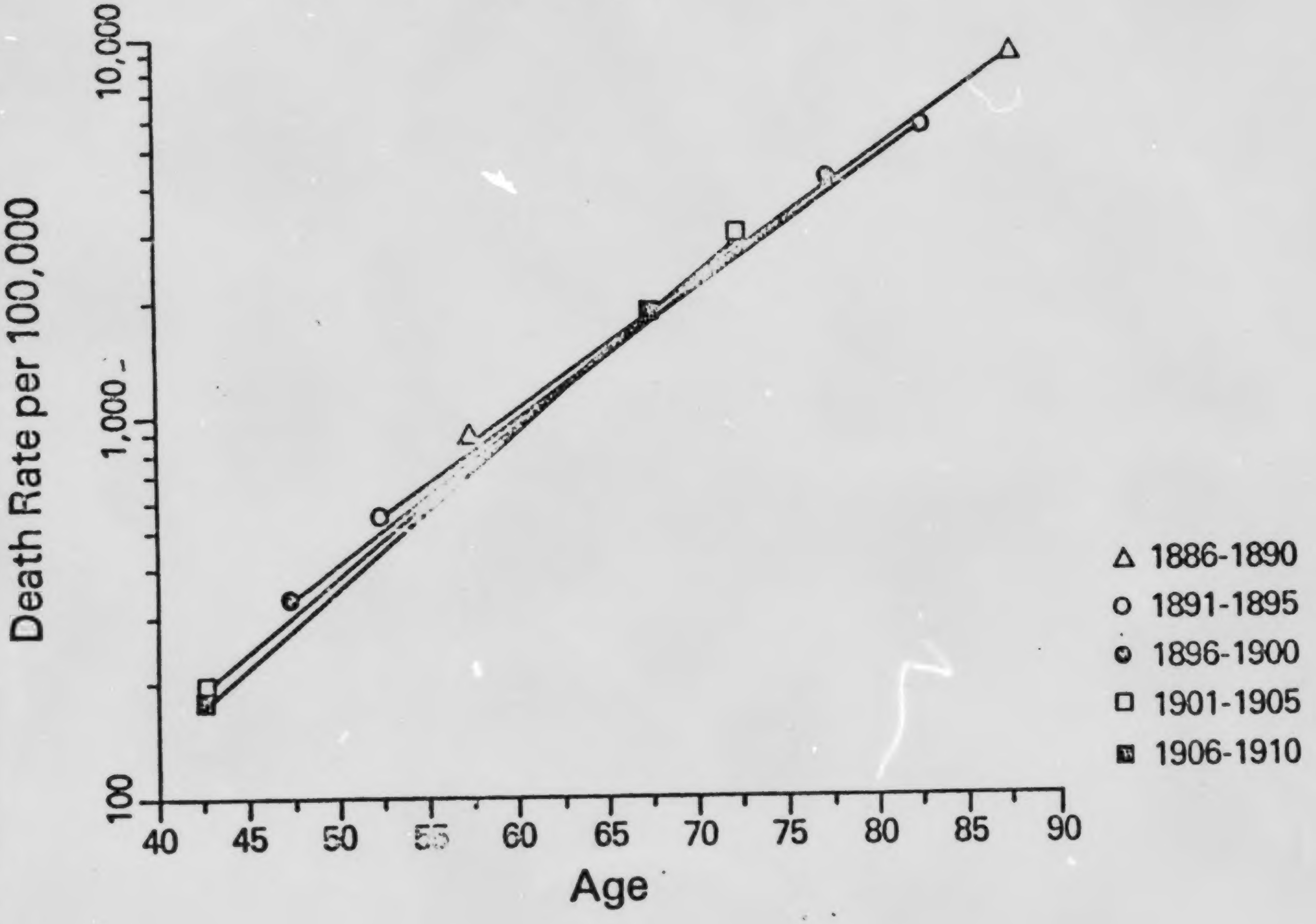
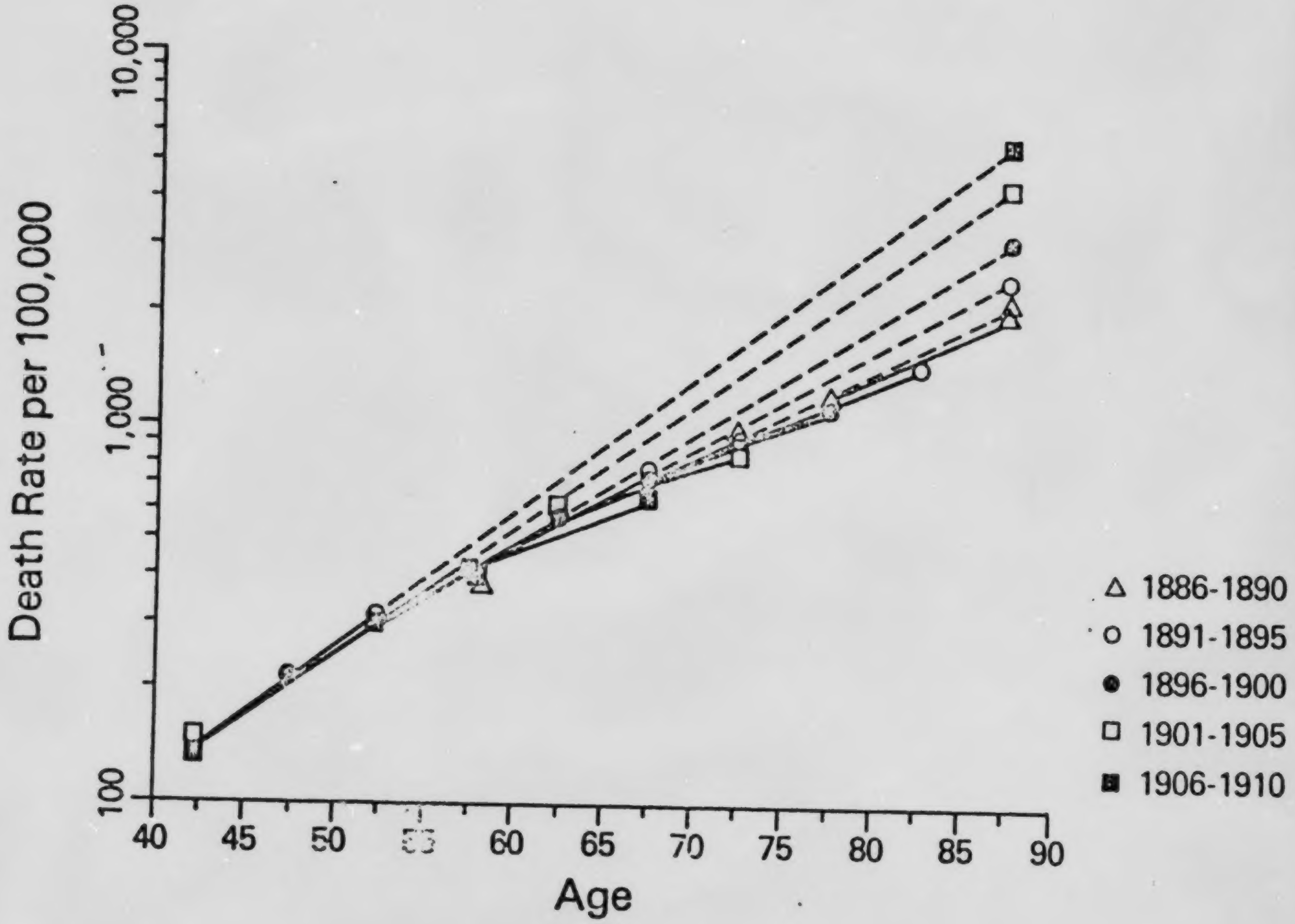


Figure 5

Two Loglinear Regression Models of Age-Specific Death Rate For Disease of Heart For Five White Male Birth Cohorts



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DIGESTION AND AGING

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INTRODUCTION

Many important questions regarding the relationship of nutrition and aging have been raised, including: What diets should be eaten, from childhood through the later years, to minimize the degenerative changes associated with old age? Can dietary modifications influence the rate of aging? Does malnutrition contribute to premature aging? Although there is substantial evidence that diet, aging, and longevity are interrelated in experimental animals (Young, 1979), our knowledge of these relationships in human populations is sparse. Even for the chronic diseases that are associated with aging, and that often require some sort of dietary modification (diseases such as atherosclerosis, diabetes, hypertension, and osteoporosis), the role of long-term dietary habits in the development of disease remains uncertain.

Certainly before "optimal" diets can be identified, it is necessary that adequate intakes of the more than 40 essential nutrients be identified for aging adults. Because knowledge of nutrient requirements among the elderly is scanty, the Recommended Dietary Allowances (RDA) for adults over age 51 have been based on an extrapolation from the nutrient needs of younger adults (Food and Nutrition Board, 1980).

In turn, the effects of aging on nutrient digestion, absorption, metabolism, utilization, and excretion must be determined before adequate or recommended intake can be estimated. As the gastrointestinal tract is the site of nutrient digestion and absorption, it is appropriate to review the literature on aging and gastrointestinal physiology to provide a basis for considering the complex issues involving nutrition and aging.

Although the differentiation of pathologic from physiologic (i.e., normative) changes of aging is difficult, particularly in the absence of longitudinal data, the following discussion focuses on those changes that seem likely to be physiologic effects of aging. There are several comprehensive reviews on gastrointestinal disease in the elderly (Bhanthumnavin and Schuster, 1977; Balacki and Dobbins 1974; Hyams, 1974; Brocklehurst, 1973; Berman and Kirsner, 1972a,b).

AGING AND DIGESTION

In the following discussion we review the literature on gastrointestinal physiology in aging with regard to four key stages of alimentation:

1. Food intake
2. Events in the gastrointestinal lumen, including swallowing, leading to the mixing of food with gastric, pancreatic, biliary, and intestinal secretions, digestion, and propulsion to appropriate locations in the intestine for absorption

3. Cellular events in the intestinal mucosa including the terminal digestion of sugars and proteins, uptake of nutrients from the intestinal lumen, nutrient processing and release for return to the circulation, and the generation and release of hormones that may influence gastrointestinal secretion, motility, and even subsequent nutrient disposition

4. Circulatory events, involving the distribution of nutrients to the rest of the body and also the enterohepatic circulation of nutrients.

FOOD INTAKE

It is not the purpose of this paper to review dietary intake surveys of the elderly; nonetheless information from such studies - data on nutrient inputs for different population groups - is needed to evaluate the clinical significance of alterations in gastrointestinal physiology that may occur with aging. Because of the differences in standards, methods, and sources of subjects, it is difficult to compare directly the various results of dietary surveys of the elderly. However, some findings occurred relatively consistently; these results are a) calcium intakes are generally deficient, particularly in women; and b) although average protein, iron, vitamin A, vitamin B complex, and ascorbic acid intakes are adequate, appreciable proportions of the elderly consume diets inadequate in these nutrients. Additionally, although average caloric intakes reported are significantly below the RDA, caloric intakes as well as standards are probably too high for our sedentary elderly people, especially women, as the prevalence of obesity is high.* Because the RDA for calories for the elderly has already been decreased, while the RDA for vitamins and minerals are generally comparable to those for younger adults, increased consumption of nutrient-rich foods may be necessary to attain adequate nutrient intakes. Dietary studies of older Americans were recently reviewed by O'Hanlon and Kohrs, (1978).

It is important to emphasize that cultural and socioeconomic factors related to the living conditions of elderly persons significantly influence their dietary intake. Some of the important factors are loneliness, poverty, unsuitable housing conditions, physical disability, apathy, mental deterioration, and inadequate understanding of basic nutrition principles (Young, 1979). For example, low hemoglobin and hematocrit values suggestive of nutritional iron deficiency are particularly prevalent in national surveys of persons over age 60. In a 6 to 8-month iron-fortification study involving more than 200 free-living Bostonians over age 60, who initially had moderately low hemoglobins (between 9 and

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*In the Ten-State Nutrition Survey, elderly men were 10%-20% obese and elderly women, 20-50% obese.

12.9 g/dl), a marked increase in hemoglobin levels (averaging 1.4 g/dl) occurred in both control and experimental groups (Gershoff et al., 1977). The authors conclude that the supplemental iron, whether in foods or as ferrous sulfate capsules, was not what raised the hemoglobin levels, and hypothesize that because the intervention study involved a great deal of personal contact, many of the participants may have changed their eating habits. This result suggests that social as well as techni- cal intervention should be included in health programs for the elderly.

Physiologic changes that accompany aging and may affect food intake include loss of teeth, impaired taste and smell, and decreased salivary secretion. Half of Americans have lost all their teeth by age 65; by age 75, the proportion increases to two-thirds (Busse, 1978). In a recent survey of 254 elderly persons living in England, 75% were edentulous and only 10% of full denture wearers had clinically satisfactory appliances; nearly 76% had pathologic lesions of the oral mucosa, 40% had oral pain, and 30% had difficulty chewing (Smith, 1979). Problems with ill-fitting dentures increase with age, and lead to restriction of dietary intake to soft foods and liquids and avoidance of hard and sticky foods. Such diets are likely to be high in carbohydrate but may be low in several of the micronutrients, especially minerals and water-soluble vitamins.

The relationship of the ability to taste and smell and eating patterns is complex. With aging, both the number of taste buds per papilla and the number of pallilae decrease, also the number of both taste and olfactory nerve endings decrease (Schiffman and Pasternak, 1979). The loss of taste buds occurs in the anterior part of the tongue initially, so that the ability to detect sweet and salty tastes is affected first; this is consistent with the complaint by some older poeople that all foods taste bitter or sour (Busse, 1978). While there is controversy about the magnitude of the change in taste thresholds with aging (Grzegorczyk et al., 1979; Fisher and Kaplan, 1970), it has been demonstrated that improved oral hygiene (Langan and Yearick, 1976) but neither supplemental zinc (Greger and Geissler, 1978) nor B vitamin supplementation (Langer, 1976) can significantly enhance taste activity in elderly people. Interestingly, Langan and Yearick (1976) also observed an intervention effect, as dietary intake improved qualitatively and quantitatively in both control and experimental groups during their 5-week study. Schiffman et al. (1976) found that elderly persons also have significantly increased odor detection thresholds; for example, over half of all elderly persons may be unable to detect the odorant in domestic natural gas (Busse, 1978).

These physiologic changes are significant in that because many elderly persons are unable to accurately discriminate food odors or tastes, they place increased reliance on texture and visual cues for the correct identification of foods; this might be one reason older people are uncomfortable with unfamiliar foods.

EVENTS IN THE GASTROINTESTINAL LUMEN

ESOPHAGUS

After ingestion, food is transported to the stomach via the esophagus. Recent esophageal motility studies (Khan et al., 1977; Hollis and Castell, 1974) indicate that some minor abnormalities, including disordered contractions and spontaneous gastroesophageal reflux, can be detected more frequently in asymptomatic elderly persons particularly in those older than age 70, than in younger adults. However, the basic swallowng pattern is maintained in the older subjects: In at least 75% of the swallows observed, peristaltic contractions and the expected response of the lower esophageal sphincter occurred following swallowing (Khan et al., 1977). The demonstration of these relatively minor abnormalities of esophageal function requires careful diagnostic effort; it is probable that clinically significant symptoms rarely result (Castell, 1973). Age-related changes in motility have not been well-documented for the remaining portion of the gastrointestinal tract.

STOMACH

Significant age-related changes in gastric physiology include decreased secretion of hydrochloric acid (decreased volume and concentration), intrinsic factor, and pepsin, which may result in decreased absorption of iron, vitamin B12, and protein, as will be discussed elsewhere, and also bacterial overgrowth (reviewed by Bhanthumnavin and Schuster, 1977, and Berman and Kirsner, 1972a; Roberts et al., 1977; Giannella et al., 1973; Fikry, 1965). The prevalence of achlorhydria in the elderly is uncertain, but 68% of 657 consecutive patients admitted to a geriatric unit were reported to be achlorhydric (Bird et al., 1977). According to the Blackman et al. (1970) calculations, normal values for peak acid output adjusted for sex and body weight decrease by as much as 40% between ages 45 and 65.

Studies of gastric motility and emptying in the elderly, and their control factors, are lacking. However, the rate of emptying has been shown to decrease in atrophic gastritis, a disorder whose prevalence increases with age and which has been associated with a predisposition to pernicious anemia and gastric carcinoma.

PANCREATIC DIGESTION

There are scattered reports in the older literature of decreased synthesis and secretion of some but not all pancreatic digestive enzymes in elderly humans. Snook, who has carried out a series of studies on the effect of diet on the rat exocrine pancreas from birth to senescence, observed significant and permanent reductions in pancreatic digestive enzyme content in aged rats, but no reduction in the apparent digestibility of dietary nitrogen or energy (Snook, 1975). Given the reserve capacity of digestive function, it is likely that such changes are not usually of clinical significance (Snook, 1974).

Indeed the range of fecal fat excretion on a constant 85-90 g fat diet was the same (3-7 g) for eight asymptomatic subjects aged 67-72 and six aged 34-42 Werner and Hambraeus, 1972). However, when the fat content of the diet was increased to 115-120 g, all but two of the elderly subjects excreted 12 g or more, while the range for the younger subjects was 3-9 g. This was interpreted as impaired intraluminal digestion. In further studies with two elderly women, fat excretion was within normal limits when the fat was distributed among four to six meals, but excessive when most of the fat load was taken in one meal, an observation which could have implications for design of optimal feeding practices for the elderly.

Similarly Pelz et al. (1968) found high fecal fat (greater than 20% of dry weight) in 17 of 43 institutionalized elderly persons; furthermore, free fatty acids were low (less than 55% of total fat) in 10 of the 17 samples, which is also consistent with decreased pancreatic lipase activity. In related work on protein utilization, fecal nitrogen excretion was doubled (to 4.0 g) in five of seven elderly patients given diets containing 1.4-1.5 g/kg of nitrogen when compared with diets containing 0.9-1.0 g/kg (Werner and Hambraues, 1972). However, only tentative conclusions concerning the magnitude of digestive insufficiency in the elderly can be drawn from these studies

LIVER AND BILIARY FACTORS

Results from a series of detailed balance studies on the effects of dietary fiber on energy utilization support the concept that age generally has no significant effect on the apparent digestibility of fat, protein, or carbohydrate, although there was a slight but significant difference in the apparent digestibility of fat between young and elderly women, 96.4% versus 94.7%, on an 80-95 g fat (30%-37% of energy) intake (Southgate and Durnin, 1970).

Bile salts secreted by the liver are critical to normal digestion and absorption of fat. Although structural and biochemical changes have been well documented in aging liver, and the ratio of liver weight to body weight decreases after about age 50, there seem to be no age-related changes in liver function in persons with histologically normal livers (Kampmann et al., 1975; reviewed by Bhanthumnavin and Schuster, 1977). However, no mechanism has been defined for the reduced serum albumin observed in the elderly (Greenblatt, 1979). Impaired induction of hepatic microsomal drug-metabolizing enzymes has been reported in aging experimental animals, but no comparable human studies have been reported.

The development of gallstones is directly related to age and sex, at least in Western societies. In a recent study, the proportion of biliary cholesterol and the lithogenic index were significantly increased in elderly asymptomatic Chilean women of normal weight who had recently had normal cholecystograms (Valdivieso et al., 1978). Only one of 12 young women compared with five of 12 elderly women had super saturated bile, but metabolic studies indicated no significant changes in the bile acid pool, or cholesterol synthesis and turnover. The linear age-related increase in intestinal absorption of cholesterol observed in rats (Hollander and Morgan, 1979) may be relevant.

Aging changes in gastrointestinal hormone production represent an important but neglected area for research.

MORPHOLOGY AND FUNCTION OF THE EPITHELIUM

INTESTINAL MORPHOLOGY

Because there is almost no literature on age-related morphological changes in the human small intestine, largely animal data are reviewed below. Penzes (1970) found no significant age difference in total carbon and nitrogen content expressed as a fraction of fat-free dry weight of female rat small intestine. Lesher and Sacher (1968) have shown that the length of the generation cycle and the time required for cells to migrate from the duodenal crypt to villous tip increase in aging mice, with a doubling of the G1 phase occurring at the end of the growth period and increases in both S and G1 phases at the beginning of "senility," around 27 months. The generation time was almost 50% longer in the old mice. In related studies on the length of the generation time of mouse epithelial stem cells in the duodenum, colon, and esophagus, the age-related prolongation of the cell cycle was caused by an increase in the G1 phase (Trasher and Gzeulich, 1965; Trasher, 1967, 1971). No age-related change in the rate of epithelial cell proliferation was observed in mouse ileum, however (Fry et al; 1962).

Moog (1977) found that both the absolute and relative weight of the small intestine increase in mice between 6 and 24 months. She ascribed the increase to epithelial growth, with significantly taller jejunal villi in the older rats, and to deposition of amyloid in the lamina propria of the terminal ileum, with the latter representing the only pathologic change found. The protein content and specific activities of three membrane-associated enzymes (sucrase, maltase, and alkaline phosphatase) were not significantly different, thus the total protein content and enzyme activities were actually greater in the older mice, because of their heavier intestines. The intestinal distribution of these enzymes was similar in adult and aged mice. Indeed, Moog observed a qualitative decrease in food intake in the older mice, per gram of body weight, that would be consistent with increased digestive and/or absorptive efficiency, perhaps associated with increased mucosal surface area.

However, the situations of mice and men are not always comparable. Histologic and histochemical studies of male Wistar rats indicate that although the number of villi in the duoderum and jejunum do not change with age, except perhaps in very old rats (Clarke, 1972; Forrester, 1972), villous atrophy with irregular architecture and low acid and alkaline phosphatase activities at all times of the day is found in the aged rats (Hohn et al., 1978). Penzes and Skala (1977) observed an age-dependent decrease in the length of the small intestine, relative to body weight, and a 25% increase in serosal circumference along its length.

These results, which suggest that the resorptive capacity of the small intestinal mucosa might decrease with age, are in accord with the conclusions of a recent comparison of normal upper-jejunal biopsy specimens from ten young and ten elderly patients (Warren et al., 1978). Xylose, iron, and vitamin B12 absorption and fecal fat excretion were normal in all subjects, and hematological findings and nutritional indexes were said to be comparable in the two groups. However, the reduction in mucosal surface area in the elderly subjects was significant at $p < 0.001$, with the examiner "blinded." The average villus height was not significantly reduced, enterocyte height was normal, and none of the histological changes described in aging mice (amyloid or collagenous infiltration of the lamina propria) were present. A reduction in mucosal surface area could be of nutritional significance in cases of marginal intake or when associated with other pathology.

INTESTINAL FUNCTION

The literature on small intestinal absorptive function in the elderly is reviewed below, first for the macronutrients (protein, fat, and carbohydrates) and then for the micronutrients (vitamins andminerals).

PROTEIN ABSORPTION

No valid studies of protein or amino acid absorption in elderly humans have been reported. Penzes and associates have used an intestinal perfusion system to study amino acid absorption in rats of different ages. In general, there seem to be no significant age differences in amino acid absorptior although the intestinal affinity for phenylalanine and proline may decrease slightly with age (Penzes, 1969, 1970, 1974a,b; Penzes and Boross, 1974; Penzes et al., 1963).

From nitrogen balance studies involving six elderly men, however, Tuttle et al. (1960) concluded that methionine requirements for elderly men were more than double those determined by Rose for young men. More recently Young, Scrimshaw, and co-workers, who have published an impressive series of studies concerning protein utilization and requirements in young and elderly persons, have recommended that 1 gram of protein per kg body weight be used as a standard in planning diets for the elderly until long-term nitrogen balance studies have been carried out (Young et al., 1976). Using the 1980 RDA for energy (Food and Nutrition Board, 1980), protein would then supply about 12% of dietary energy versus about 10% using the RDA for protein of 0.8 g/kg. As nitrogen balance is a function of protein intake, digestion, absorption, metabolism, utilization, and excretion, research to directly evaluate protein digestion and absorption would be useful in defining the protein requirement for the elderly.

FAT ABSORPTION

As discussed previously, abnormally high fecal excretion of fat has been noted in several surveys of elderly persons. Furthermore, there is some biochemical evidence suggesting that the defect is present at the stage of fat digestion. While the prevalence of steatorrhea found in screening apparently healthy elderly persons may be as high as 10% (Montgomery et al., 1973), no studies have examined intestinal absorption of fat directly. As mentioned previously, cholesterol absorption was reported to increase linearly with age in rats (Hollander and Morgan, 1979).

Webster et al. (1977) used micronephelometry, a technique based on the light-scattering properties of particles, to study chylomicron appearance in blood after consumption of a meal containing 100 grams of fat. There was a significant difference ($p < 0.01$) between young controls (average age 26) and elderly subjects (average age 82) in the maximum difference in chylomicron appearance at 3 and 4 hours. However, when 3 grams of pancreatic extract was added to the fatty meal, the difference was smaller and no longer significant. These results indicate that the short-term (4-hour) kinetics of fat absorption is significantly different in elderly patients. However, it is not possible to ascribe these differences to reduced pancreatic function because gastric emptying was not complete by 4 hours in over 80% of the elderly subjects, compared with 50% of young controls, thus the possibility of impaired intestinal absorption cannot be excluded.

It should be noted that gluten-sensitive enteropathy, which can cause fat malabsorption, occasionally presents after age 65 (Price et al., 1977; Collins, 1966). Of 47 patients over age 50 without inflammatory bowel disease who presented with steattorhea, 16 had celiac disease, 14 had pancreatic insufficiency, and of 8 who had had a partial gastrectomy, three with fecal fat excretion greater than 12 g/day had an additional reason for malabsorption - gastrocolic fistula, bacterial overgrowth in the afferent loop, or extrahepatic biliary obstruction (Price et al., 1977). Furthermore, causes were found for all but one case of steatorrhea.

CARBOHYDRATE ABSORPTION

Next we turn to carbohydrate absorption in the elderly. Oral glucose tolerance in man and rats declines with age, although the precise mechanism remains uncertain. Davidson (1979), in reviewing the effect of aging on carbohydrate metabolism, noted that 1-2 hour postprandial glucose levels increase 4 mg/100 ml per decade, which indicates that intestinal glucose absorption is probably not the rate-limiting step in glucose utilization in older persons.

Klimas (1968) used an intestinal loop technique to study glucose absorption at several points during the lifespan of male rats. There was no significant change in glucose absorption, whether expressed as mg per hour, mg per 100g body weight, or mg/cm of intestine per hour, after the end of the growth period. In this study, the ratio of intestinal weight to body weight remained stable throughout adult life.

D-xylose is a pentose sugar that is absorbed actively, predominantly from the jejunum, by a pathway similar to that for the hexoses. Because xylose absorption does not require bile salts or pancreatic enzymes, xylose malabsorption is considered suggestive of damage to the small intestinal mucosa. Based on the observation that the average urinary excretion of xylose is decreased in persons older than age 65 (Fowler and Cooke, 1960), some concluded that a generalized decrease in intestinal absorption might be a factor in the aging process. However the test depends on urinary excretion of absorbed sugar, and the careful studies of Guth (1968) and Kendall (1970) established that the inverse relationship between age and xylose excretion is primarily caused by deteriorating renal function, at least to age 80.

Webster and Leeming (1975) found no age-related difference in the rate of gastric emptying but evidence of impaired absorption in 26% of elderly patients (average age 81) given oral and intravenous xylose tests, which continues Guth's finding of decreased intestinal absorption of xylose after age 80. The decline of renal function has been studied cross-sectionally and longitudinally in the Baltimore Longitudinal Study of Aging. The results indicate that creatinine clearance shows a progressive linear decrease after age 34 and that the rate of decrease increases after age 65 in healthy free-living men (Rowe et al., (1976). Between ages 30 and 90, creatinine clearance decreased by 33%.

Lactose, the disaccharide present in milk and milk products, is a carbohydrate of particular nutritional significance. In humans (and experimental primates), jejunal lactase activity often decreases during childhood while the activities of other α-disaccharidases (cellobiase, maltase, palatinase, sucrase, and trehalase) remain constant from birth throughout adult life (Welsh et al., 1973, 1974). Although some adults maintain high lactase levels, lactose intolerance is the rule rather than the exception in all ethnic groups but caucasians (Caskey et al., 1977; Bayless et al., 1975). While the amount of lactose needed for symptoms to develop varies, most studies indicate that the lactose contained in one glass of milk (12.5 grams of lactose) can be tolerated by most lactase-deficient subjects (Debongnie et al., 1979).

However, elderly persons may avoid milk and milk products, which are also important sources of nutrients such as calcium, protein, and riboflavin, because they associate consumption of these foods with the development of cramps, bloating, abdominal discomfort, and diarrhea. In a double-blind comparison of tolerance of 87 healthy elderly persons to lactose-containing and lactose-free dairy drinks, Rorick and Scrimshaw (1979) found that symptoms other than lactose malabsorption were responsible for the symptoms of intolerance that were reported. None of the malabsorbers responded exclusively to the lactose-containing drink, and similar proportions, around 70%, of both absorbers and malabsorbers were asymptomatic with each drink. These results support the contention that moderate consumption of milk by the elderly is not contraindicated, despite the prevalence of lactose intolerance.

MICRONUTRIENT ABSORPTION

Low serum vitamin and mineral concentrations are frequently observed in casual surveys of elderly population groups, but few studies have attempted to distinguish effects at the stages of dietary intake, absorption, utilization, metabolism, and excretion. Studies related to the absorption of vitamins, minerals and trace elements by elderly persons are discussed below.

WATER-SOLUBLE VITAMINS

However, Lazarov (1977) reported that old male Wistar rats absorbed only 15% of a 0.2 mg dose of thiamin, while young rats absorbed 80% of the same dose. There was no significant difference in thiamin absorption when 24 elderly (average age 82) inpatients and 21 younger (age 49) subjects were compared (Thomson, 1966).

The evidence available concerning riboflavin includes a brief case study of four elderly patients reportedly suffering from "chilosis" (sic), for whom large oral doses of riboflavin were ineffective but in whom intramuscular doses rapidly cleared up the deficiency (Archambault, 1974).

Vitamin B12 and folate would seem to be the vitamins for which the elderly might be at particular risk of deficiency. The age- related change in gastric acidity mentioned earlier that can lead to hypo- or achlorhydria may be associated with impaired release of intrinsic factor (King et al., 1979; Carmel, 1973), (Ardeman and Chanarin, 1966), and also increases the susceptibility to bacterial overgrowth (Roberts et al., 1977) and perhaps resultant competition for available vitamin B12. Vitamin B12 malabsorption can also occur with folate deficiency (Forshaw, 1969), which is not uncommon in the elderly (Runcie, 1979). Furthermore, persons on limited incomes and often with inadequate food preparation facilities, such as the elderly, may limit their intake of meat and eggs, which represent the best dietary sources of vitamin B12, as well as fresh fruits and vegetables, the best sources of folic acid.

In fact, absorption by patients with hypochlorhydria of 57Co vitamin B12 incorporated in egg was considerably less efficient than absorption of radio-labeled cyanocobalamin (Doscherholmen and Swaim, 1973). Carmel (1978) described a vegetarian of 25 years duration who developed severe neurologic abnormalities due to vitamin B12 deficiency. In this patient, who also had gastritis, achlorhydria, and decreased intrinsic factor secretion, the Schilling test was normal but absorption of vitamin B12 given with ovalbumin was subnormal. The author concluded that neither restricted intake (0.3-1.2ug vitamin B12 daily) nor subtle malabsorption alone was sufficient but that both were required to produce clinical deficiency. Similarly, folylpolyglutamates ingested as yeast were poorly absorbed by elderly institutionalized subjects, although synthetic folylmonoglutamate was equally well absorbed by elderly and young persons (Baker et al., 1978).

It is therefore of great interest that the first major effort to evaluate vitamin B12 status in free-living U.S. elderly indicated that all serum vitamin B12 levels were normal in 111 low-income urban elderly, who were about 30% black and 20% Spanish American (Bailey et al., 1980). The average serum concentration was 700 pg/ml, well above the 200 pg/ml lower limit of normal.

In contrast, 70% of this population had erythrocyte folacin levels below normal, 160 ng/ml, but there was no evidence of iron deficiency, (Bailey et al., 1979). These authors and others have concluded that poor folacin status is the more likely cause of the erythrocyte macro- cytosis frequently noted in surveys of the elderly. Major causes of folate deficiency in the elderly include nutritional deficiency, small bowel disease (diverticula, stricture, previous surgery, colonization), and drug-folate antagonism (Runcie, 1979).

Baker and coworkers (1978) have hypothesized that age-related changes in the gut may lead to impaired synthesis of small-intestinal enzymes, including folate conjugase, thereby decreasing absorption of dietary folate, and exacerbating folate deficiency. While the peak increments in circulating folate levels after ingestion of 35 grams of yeast (containing 1.9 mg of available folates, as polyglutamates) were 34 and 4.6 ng/ml for 12 young and 24 elderly subjects, respectively, a difference of almost an order of magnitude, there was no significant difference between groups after 1.9 mg of folylmonoglutamate was ingested.

However, Elsborg (1976) reported that folic acid absorption, as estimated by urinary excretion of tritiated folic acid, was not significantly affected by age or sex in 64 randomly selected, non-folate-deficient subjects aged 23 to 70 years. Nineteen of 53 elderly patients (average age 72) with nutritional folate deficiency initially had impaired absorption of folic acid, which returned to normal after 1 month of supplementation. All but three of these patients had normal serum vitamin B12 concentrations (Elsborg, 1976).

The discrepancy between these two studies may involve pre-existing folate and/or vitamin B12 deficiency. In the study by Baker et al., 21% of the subjects had circulating folate levels below 4 ng/ml, and no vitamin B12 concentrations were reported. All of Elsborgh's subjects were initially folate deficient but only 6% had subnormal serum vitamin B12 concentrations. It may be that prolonged folate deficiency, regardless of age, can lead to subsequent folic acid and/or vitamin B12 malabsorption. Further studies of food folate absorption and perhaps folate conjugase activity in folate and vitamin B12-repleted elderly persons would seem to be in order.

Diets low in folic acid are also likely to be low in ascorbic acid. In vitro studies generally indicate that an age-related decrease in ascorbic acid uptake is related to decreased collagen synthesis in several tissues (Patniak, 1971). In humans, the concentration of ascorbic acid in several organs reportedly decreases with age, but because these concentrations can be increased by oral supplementation, this may not reflect impaired absorption (Patniak, 1971). Low circulating concentrations of ascorbic acid are prevalent among elderly persons, particularly smokers, those with gastrointestinal disease, and those who are institutionalized (Booth and Todd, 1972). Restricted intake is a likely cause of low ascorbic acid concentrations in at least the latter two groups, but no studies examining ascorbic acid absorption by healthy elderly persons have been reported.

In a recent nutrition survey of nearly 200 mostly institutionalized elderly persons (average age 79) from Belfast, a biochemical vitamin or mineral deficiency was observed in 91% of the nonsupplemented group and 64% of the multivitamin-supplemented group (Vir and Love, 1979). The prevalence of specific deficiencies was 29% for ascorbic acid, 14% for thiamin, 7% for riboflavin, and 42% for vitamin B6. Regular multivitamin supplementation reportedly normalized the blood vitamin levels of ascorbic acid, thiamin, and riboflavin in all or nearly all, but failed to normalize the vitamin B6 level in 20% of the subjects. Based on this evidence and prevalence data, these authors have suggested than an increased vitamin B6 allowance be considered for the elderly. However, no vitamin B6 absorption or utilization studies involving elderly subjects were reported.

FAT-SOLUBLE VITAMINS

Yiengst and Shock (1949) found no age difference in the peak plsma vitamin A concentration achieved following an oral dose of 100,000 U of vitamin A, but noted that the peak occurred earlier in men under age 70, probably as a reflection of earlier gastric emptying. In a recent perfusion study, vitamin A absorption in rat proximal small intestine increased linearly with age, from 25% at 1.5 months to 37% at 39 months (Hollander and Morgan, 1979). In the latter study, there was no similar increase in intestinal length or weight with age, and endogenous pancreatic and biliary secretions were excluded. No studies of vitamin E or K absorption in aging are available.

VITAMIN D AND CALCIUM

Somerville et al (1977) observed identical serum 25-hydroxyvitamin D (25-OH-D) responses in young controls and 18 elderly women (average age 83) after 2 weeks of therapy with cholecalciferol, 10,000 IU/day. However, as discussed below, Gallagher et al. (1979) found significantly lower levels of serum 1,25 dihydroxy vitamin D, the physiologically active form of the vitamin, in elderly persons.

Biochemical vitamin D deficiency occurs in some groups of elderly persons, particularly those who are institutionalized. In Vir and Love's (1979) survey, half of 40 elderly patients from long-stay geriatric units had 25-OH-D levels below 3.8 ng/ml, and biochemical osteomalacia was found in about 8% of all subjects tested. Hodkinson et al. (1973), who emphasize that coexisting reductions of both dietary vitamin D intake and exposure to sunlight are important in the genesis of osteomalacia in the elderly, have suggested that the term "osteomalacia of the housebound" might better reflect the situation.

Osteomalacia is a bone disease whose incidence increases with age, particularly in caucasian women after the menopause. Although the etiology of osteoporosis is not understood, calcium and vitamin D interrelationships are considered important. Studies using several different approaches indicate that intestinal calcium absorption decreases with aging in both men and women, particularly after age 70 (Gallagher et al., 1979; Bullamore et al., 1970). All 30 patients over age 80 studied by Bullamore's group in Leeds had significant malabsorption of calcium. However, calcium absorption was reported to be normal in 18 elderly institutionalized women in Montreal (Somerville et al., 1977). The explanation for these contradictory results may be the vitamin D status of the Montreal women - all had normal serum 25-OH-D levels before the study began, about 35% were exposed to sunlight for approximately 3 hours daily during the summer months, and they may have had a significantly higher dietary intake as well (169 vs. 64 IU/day reported by Hodkinson et al., 1973). No information regarding the vitamin D status of the English subjects was reported.

Gallagher et al. (1979) have systematically examined the interrelationships of age, calcium intake and absorption, and vitamin D metabolism in 94 normal volunteers (age 30 to 90) and 52 untreated women with postmenopausal osteoporosis. As shown clearly in the figures of this paper a) fractional calcium absorption decreases significantly with age; b) fractional calcium absorption and dietary calcium intake are not significantly correlated in the elderly subjects, although the correlation approaches significance ($p < 0.02$) in subjects under age 65; c) although there was no significant age difference in serum 25-OH-D levels, average 1,25 dihydroxy vitamin D levels were significantly lower in the elderly group; and d) serum 1,25-dihydroxy vitamin D levels and intestinal calcium absorption were significantly correlated at all ages. A comparison of these relationships in 27 patients with osteoporosis and 20 normal subjects indicated no significant differences in 25-OH-D or dietary calcium intake, but significant differences in calcium absorption and 1,25-dihydroxyvitamin D levels.

Other work indicates that adaptation to lower calcium intake is also impaired in elderly subjects. Ireland and Fordtran (1973) used a triple-lumen perfusion system to study calcium absorption from the proximal jejunum in healthe young (average age 28) and elderly (average age 68) adults, who were adapted for 1-2 months to diets containing 300 and 2000 mg of calcium. Calcium absorption after adaptation to the low calcium diet was significantly greater in the young subjects, and the adapted young subjects consistently absorbed more calcium than older people, who appear to have a blunted adaptive response to low calcium intake.

Further research is needed to define the cause of the age-related decrease in intestinal calcium absorption and adaptation to decreased intakes, to establish its role in postmenopausal and osteoporotic bone loss, and to elucidate the mechanism(s) responsible for the decreased serum concentration of 1,25-dihydroxyvitamin D observed in elderly persons. Although calcium absorption, serum 1,25-dihydroxyvitamin D, and 25-hydroxyvitamin D 1 -hydroxylase are decreased in aging rats, calcium absorption improved when either 1,25-dihydroxyvitamin D or 1 -hydroxyvitamin D was given (Horst et al., 1978). Whether the decreased 1,25-dihydroxyvitamin D concentration that occurs in human aging is responsible for the impaired calcium absorption and adaptation remains to be established.

OTHER MINERALS

Possible causes of the iron deficiency observed in elderly persons include inadequate intake, blood loss, and changes in iron absorption or utilization. In achlorhydria, the absorption of ferric iron is reduced, while the absorption of heme iron is not affected (Jacobs et al., 1964). Marx (1979) compared iron absorption in active elderly persons and young adults, all with normal iron status by blood and bone marrow examinations, by using a double-isotope technique that allowed the differentiation of mucosal uptake, mucosal transfer, and retention of iron. There was no age difference in iron absorption, but red cell iron uptake of retained iron was about one-third lower in the elderly subjects. Young and old patients with uncomplicated iron deficiency had similarly increased iron absorption. Marx concluded that decreased iron absorption was not the cause of iron deficiency in the elderly.

The only other trace mineral that seems to have been examined in aging is zinc. Linderman et al. (1971) observed statistically significant age-related decreases in the plasma zinc concentrations of some 250 hospital personnel and institutionalized subjects, aged 20-53 years. These results would be consistent with impaired absorption or decreased serum transport proteins; as mentioned previously, there is an age-related decrease in the serum albumin concentration (Greenblatt, 1979).

CIRCULATORY EVENTS

The discussion of age-related alterations in circulatory events will be short, as so little information is available. Perhaps the best example is malabsorption caused by atheroma of the mesenteric vessels. Dardik et al. (1965) described the clinical course of a 70-year-old woman with malabsorption and decreased intestinal motility secondary to superior mesenteric artery occlusion and celiac artery narrowing. However, effects of aging on the mesenteric venous circulation have not been elucidated. Studies examing the enterohepatic circulation of nutrients in aging would also be of interest.

SUMMARY

Nutritional problems in the elderly population have been identified in many studies; too little attention has been paid to research on changes in the digestive systems in man during aging. The information which is available and reviewed in this paper documents minimal clinically significant changes in digestion and absorption during the process of normal aging. Firstly, the digestive apparatus has a large natural reserve as do many other organ systems. There are not enough studies that seek to identify subtle changes in efficiency with aging. There is strong evidence that the intestine does lose some of its capacity for physiological adaptability and this may account for the lessened ability of the intestine to adapt to a low calcium intake in later adult years. Interestingly, this may be less an affect of changes within the intestine itself than an affect of changes in the kidney, in the activation of hormonal vitamin D. Thus, with present knowledge, only a small part of the problem of nutritional deficiency in the elderly is attributable to loss of digestive function with normal aging.

We do find more commonly that often changes in nutritional status of the elderly and even in absorptive function can be attributed to concurrent disease or drugs. There are many drugs that interact with nutrients and absorption and utilization and elderly patients tend to be on a large number of medications. Many diseases of the gastrointestnal tract and others including diabetes, can influence gastrointestinal function and all too often these drugs and these diseases have not been carefully screened out in studies of the specific effect of aging on intestinal function.

Thus, a good deal more research needs to be directed at the specific effects of aging on the digestive tract, particularly in studies relating to vitamins and trace minerals. More clinical attention needs to be given to drug-nutrient interactions in the elderly, including the effects of ethanol, and to the impact of other diseases on digestive function and eating behavior. Certainly whenever food intake is restricted for either clinical or sociological reasons, vitamin, mineral and other nutritional supplementation may be an important part of management and prevention of nutritional deficiencies.

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THE EPIDEMIOLOGY OF INJURY IN THE ELDERLY

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EPIDEMIOLOGY OF INJURY IN THE ELDERLY

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ABSTRACT

Epidemiologic studies show that injury is a nonrandom event of considerable consequence to older people. The elderly have high death rates and high dysfunction and disability rates from falls, fires and contact with hot substances, and vehicular crashes to pedestrians and occupants of motor vehicles, even though children have the highest injury rates, for all injuries combined. Injuries occur when task demands exceed performance capability, at the point of abnormal energy exchange. Although it is often not possible to know intention in injury so that there is inevitably some overlapping between suicide or homicide and unintentional injury, the focus of this review is unintentional injury.

Adequate epidemiologic studies of non-fatal injuries are still somewhat scarce, though several well-designed studies have been reported. Mortality data are available from several sources, notably the National Safety Council and National Center for Health Statistics.

There are notable race and sex differences in injuries in the elderly. Women have more fall injuries and higher rates of fall injury than men. Men have higher injury rates from burns and motor vehicle crashes (including pedestrian injuries), and for each of the 3 categories of injury men have higher death rates than women. Before the age of 75, non-white males have the highest rates of death from injury. At age 75, however, white males cross over to have a much lower rate of death from injury than do non-white males.

More than half the deaths due to unintentional injury in those age 65 and older is due to falls. White males have the highest death rates from

falls, then white females. The most common injury to old people who fall is fracture. There is hope that basic and clinical research on osteoporosis will lead to reduction in fractures from falls in elderly white women.

More than a fourth of the injury fatalities for people 65 and older are from motor vehicle crashes. 9.3% of all licensed drivers are age 65 or older. Older drivers drive fewer miles than other people, and they tend to limit their driving to daytime and relatively less stressful conditions. Nonetheless, when miles driven are taken into account, the relatively small number of crashes is equivalent to a crash rate that is exceeded only by the under 25 years age group. The elderly have high fatality rates from motor vehicle crashes. In 1973-74, when fuel prices increased and the maximum speed limit in the U. S. was lowered to 55 mph, motor vehicle death rates dropped for all age groups, but in the 65 and over age categories the decrease was the sharpest and the elderly was the only age group which sustained lower death rates through the year 1979. Driving exposure data are needed for interpretation of that finding. Errors of perception or judgment characterize motor vehicle violations of the elderly; high speed or alcohol-related violations are not prevalent.

Pedestrian deaths account for more than a third of motor vehicle deaths to people age 65 and older. Most fatal injuries to elderly pedestrians occur at intersections, in contrast to child pedestrian fatal injuries which occur at higher rates between intersections.

Transportation is very important to the elderly, both for provision of goods and services and as a measure of independence and self-esteem. With respect to countermeasures specific to motor vehicle crashes, improved vehicular and roadway design are required, as is better emergency care, better health care for the elderly generally, and improved transportation systems. There is insufficient evidence for a recommendation of systematic license restriction either by age or medical condition.

The death rate from burns is higher in the elderly than in any other age group, including young children. Given the event of thermal injury, old people are much less likely to survive. The most frequent type of thermal injury resulting in hospitalization for old people is scalds (next flames, then contact burns), but conflagrations lead to most of the burn deaths. If tap water scalds were eliminated by hot water temperature regulation as proposed by the U. S. Consumer Product Safety Commission, it is estimated that more than 1,100 tap water burn injuries to people over 65 could be avoided annually.

There is some evidence that elderly people might not seek emergency treatment as soon as younger people, and there is some evidence of preferential emergency treatment of young people.

Diminished ability to perceive hazard, and to respond effectively generally contribute to higher injury rates among the elderly, as does lower injury threshold. Some of those factors are associated with normal aging, and some are related to disease. Some investigators have shown associations between injury rates and cardiovascular disease or impaired mental status, but the magnitude of those relationships is unclear, both because of lack of appropriate controls in studies and inconsistent findings even in well designed studies.

Injury control demands new ways of thinking from health professionals. Previous efforts, primarily educational programs directed toward individuals, have been largely unsuccessful. Those who plan interventions should focus on efforts that do not require the active participation of individuals for effectiveness. A two dimensional matrix that includes on one dimension pre-event, event, and post-event phases; and on the other, human, vector, and environment, guides systematic attention to injury control. Environments for the elderly must be made more negotiable and less hazardous.

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Table 13. Deaths from burns, by age groups, for the U.S., 1977.

Figure 4. Survival rates of burned patients in different age groups, by percentage of total body area burned.

THE EPIDEMIOLOGY OF INJURY IN THE ELDERLY[1]

An injury is no accident (Doege, 1978) in any age group, and the heavy consequential burden of disability and death borne by the elderly who are injured is more than a reflection of fate or chance. For all injuries combined, population-based death rates are highest in the elderly, and are twice as high for the elderly (75-84 years old) as for teenagers (15-24 years old), the group with the second highest death rates due to unintentional injury. (U. S. National Center for Health Statistics, 1980)

Injury is the leading cause of death in persons aged 1 to 34. Among persons of all ages, injuries are the fourth leading cause of death. In 1979 injuries were the fifth cause of death in persons 65 to 74 years of age, the seventh cause of death for persons 75 to 84, and the fifth leading cause for persons 85 and older. The death rate for unintentional injury per 100,000 persons for 1979 was 47.9 for all ages combined, 57.1 for 65 to 74 years, 133.4 for 75-84 years, and 265.9 for persons 85 and older. (Data from Vital Statistics Report [Provisional Statistics], Annual Summary for the United States, 1979.) Put another way, the older population is over-represented in deaths due to injury: in a recent year (1978), 22.9 percent of all the injury fatalities occured to the 10.7 percent of the pupulation who were 65 years and older.

It is not true, however, that a high injury death rate is associated with a high injury rate.

Table 1. Injury Rates per 100 persons, By Age, United States, 1978*

Age	Rates
All Ages	31.6
Under 6	33.2
6-16	38.3
17-44	34.8
45-64	23.1
65 and over	21.9

*Source: Current Estimates from the Health Interview Survey, U. S., 1978, DHEW Publication No (PHS) 80-1551:19.

Although the method of data collection in the Health Interview Survey provides a conservative estimate of events for the elderly, injury rates are substantially lower among the elderly than in younger persons. Over-all then, older people have low injury rates compared to other age groups, but high case fatality rates. In addition, rates of days of restricted activity and of bed disability and hospitalization due to injury are relatively high in older people. For example, the injury rate among people 65 years and over is only 57% of the injury rate for children 6-16 years of age, yet old people have 2.28 times the days of restricted activity as 6-16 years olds and almost 3 (2.99) times as many bed disability days due to injury each year. Therefore, even though in absolute numbers injuries in older people are relatively few, the disability, dysfunction, utilization of health services and death rates given the event of injury are reason for further scientific efforts.

Over the decade from 1968 to 1978 the number of deaths due to injury and the death rate due to injury generally declined at all ages. Within the decade the age adjusted death rate for injuries decreased 19.5%, but increased 1.1% between 1977 and 1978. The increase between 1977 and 1978 was the result of a 4.5% increase in the death rate for motor vehicle crashes. Age-adjusted death rates for motor vehicle crashes decreased 17.4% between 1973 and 1974 when there were serious gasoline shortages and legislation was passed establishing a maximum speed limit of 55 miles per hour. The following year, 1974 to 1975, saw a further decrease of 2.3%. Each year since then the death rate (age-adjusted) for motor vehicle crashes has increased. (National Center for Health Statistics, Final Mortality Statistics, U.S., 1978). Deaths for the 75 and over age group declined during the decade 1969 to 1979 from 17,373 to 14,800, with the greatest improvement in deaths due to falls, down 30% from 10,225 to 7,100. National Safety Council, 1980:20). Table 2 shows death rates for unintentional injury by age for the United States for 1975 lower in all age groups than in 1969.

Table 2. Death Rates Per 100,000 Population for Unintentional Injury By Age: United States, 1969 and 1975*

Age in Years	1969	1975
0-19	37.2	15.9
20-34	64.9	30.2
35.54	54.7	25.4
55-64	68.1	43.1
65-74	89.6	52.2
75	236.7	143.9

*Source: Underlying Cause of Death Statistics, U. S. 1975, 1969; Provisional Census, 1975.

Table 3 shows rates for unintentional injury by age, race, and sex, for the U. S. for 1975 and 1969. In both years non-white males have the highest rates at all ages until age 75, when white males cross over to have the highest rate. At all ages, for all injury types, males have higher death rates from injury than do females. (Iskrant and Joliet, 1968)

Table 3. Death Rates Per 100,000 Population for Unintentional Injury By Age, Race, and Sex: United States, 1975 (and 1969)*

	White		Non-white		
Years	Male	Female	Male	Female	TOTAL
0-19	20.9 (48.5)	9.9 (20.7)	22.3 (66.9)	15.1 (33.4)	15.9 (37.18)
20-34	44.7 (99.5)	13.3 (22.7)	61.4 (155.7)	19.0 (32.5)	30.2 (64.9)
35-54	33.3 (75.9)	13.4 (25.8)	67.7 (153.3)	23.8 (38.0)	25.4 (54.7)
55-64	69.1 (95.7)	17.7 (36.1)	79.2 (169.0)	27.4 (45.6)	43.1 (68.1)
65-74	78.8 (123.0)	30.5 (58.9)	93.1 (170.8)	35.9 (72.1)	52.2 (89.6)
75+	173.8 (280.3)	131.2 (214.4)	144.8 (237.5)	101.1 (160.3)	143.9 (236.7)

Source: Underlying Cause of Death Statistics, United States, 100% sample, 1975; 1969.
*1969 rates in parentheses

Three types of events account for most of all unintentional injury deaths among the elderly: falls; motor vehicle collisions, including those involving pedestrians; and fires and contact with hot substances. The relative distribution of types of fatal injury in the elderly is shown in Figure 1. Before reviewing research in each of those classes of injury which are particular problems to older people, we must address conceptual issues related to definition of accidents or injury and explain an epidemiologic approach to injury, its prevention and consequences.

Injury and disease alike have been considered by primitive peoples to be the visitation of outraged spirits or the effect of human misbehavior directed through some evil eye. More than two thousand years ago Hippocrates provided alternatives to the power of ghosts, witches and demons in the cause of disease through his systematic account of the effect of environment on health. To a certain extent Hippocratic thought influenced ideas about disease until the advent of the germ theory dominated thinking about disease; only in the last two

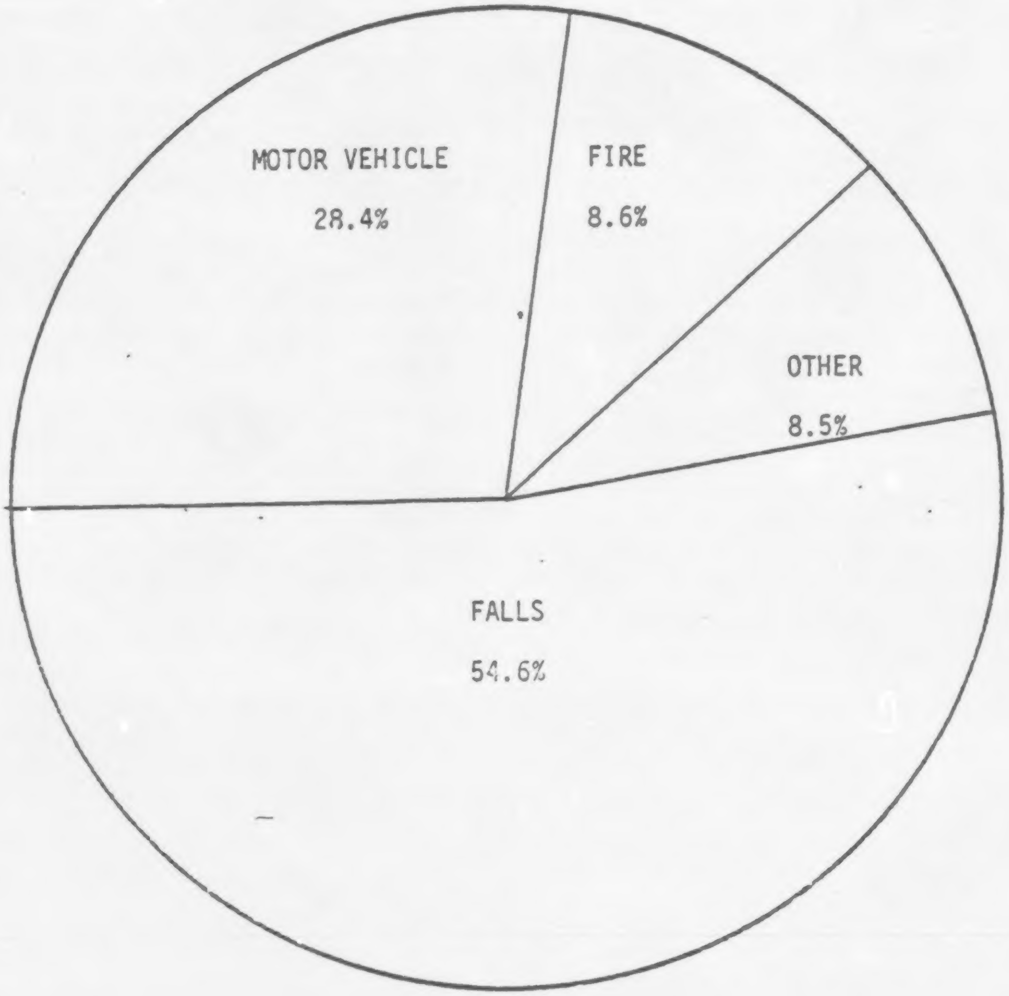

Figure 1. Distribution of Types of Fatal Injury Events in Persons 65 Years and Older; United States, 1975.

Source: Underlying Cause of Death Statistics, United States, 1975, 100% sample.

decades have we considered multicausal approaches to disease and multivariate approaches to its control. Epidemics of infectious disease prior to this century probably allowed for little consideration of injury and certainly the germ theory, with its emphasis on an infrectious, external agent left injury as "accidental happenings" without any rational, observable explanation. Injury or so-called accidents came to be viewed as a health problem in the 1930's and 1940's; it has never in any sustained way been studied with the same rigor accorded disease.

The word "accident" will continue to be used commonly by lay people, by epidemiologists have, by and large, stopped using that term, replacing it with injury or injury events (Waller, 1973). Definitions of accidents refer to random or chance events, yet existing data indicate that accidents, like diseases, are nonrandom events. Epidemiologists are concerned with the identification and understanding of nonrandom patterns of events. The term accident also has the connotation of bad luck, carelessness, sinfulness, acts of God, and other moralistic terms which tend to exclude scientific approaches to this problem.

Although John Gordon's paper in the 40's (Gordon, 1949) encouraged a rash of so-called accidents studies with a long list of causative "agents" such as cars, guns, knives, medicines, stoves, rugs, stairs, etc., the work of King (1949), Haddon (1970) and Waller (1972) suggest that the agent in all injuries is energy in one form or another (Kinetic, chemical, thermal, radiation, electric), that most previously identified agents were only vectors, and that "excessive levels of energy exchange or, rarely (as in drowning or poisoning) excessive interference with normal patterns of energy transfer produce tissue damage" (Waller & Klein, 1973). Three phases in the occurrence of injury and its outcome are identified, "The pre-injury phase, which includes the events that lead to the unintentional dislocation of energy from its usual setting, the injury phase in which energy is transferred to human tissue, and the post-injury phase in which the adequacy of emergency and follow-up care often play an important role in determining ultimate outcome....A brief review of the pre-injury phase will help focus on the nature of the problem....Basically the process of dealing with energy sources in our environment depends on two factors, the performance level of the person and the task demands involved in using the energy (Waller, 1973)." The task of walking from one room to another is less demanding than is the task of walking across a busy city street. In either type of task, however, it is only when the demands of the task exceed the performance level that a harmful exchange of energy occurs.

Once energy is released, the occurrence of an injury is dependent upon the amount of energy released, its rate of transfer, its distribution over body tissues and the nature of the body tissue itself. Thus "tissues capable of spreading the load, such as the pliable bones of young children resist serious injury more effectively than do tissues that localize energy, such as the brittle bones of the elderly." (Waller & Klein, 1973)

In the post-injury phase both the nature of the injury and the adequacy of emergency and definitive care determine survival and amount of promptness of recovery. A graphic representation of Waller's model appears as Figure 2.

Even though it is clear that abnormal energy transfer is the cause of injury a great deal of research effort is still directed toward trying to find individual behavioral characteristics to change to prevent "accidents". The notion that some people are "accident prone" has no epidemiologic support; proneness is not a stable entity. (Arbous & Kerrich, 1951; Hogue, 1972).

Epidemiology is concerned not only with the understanding of determinants of abnormal conditions or health states, but also with identifying and testing methods for control of abnormal conditions such as injuries, and maintenance of health (Haddon, (1980) and Baker (1975) have suggested

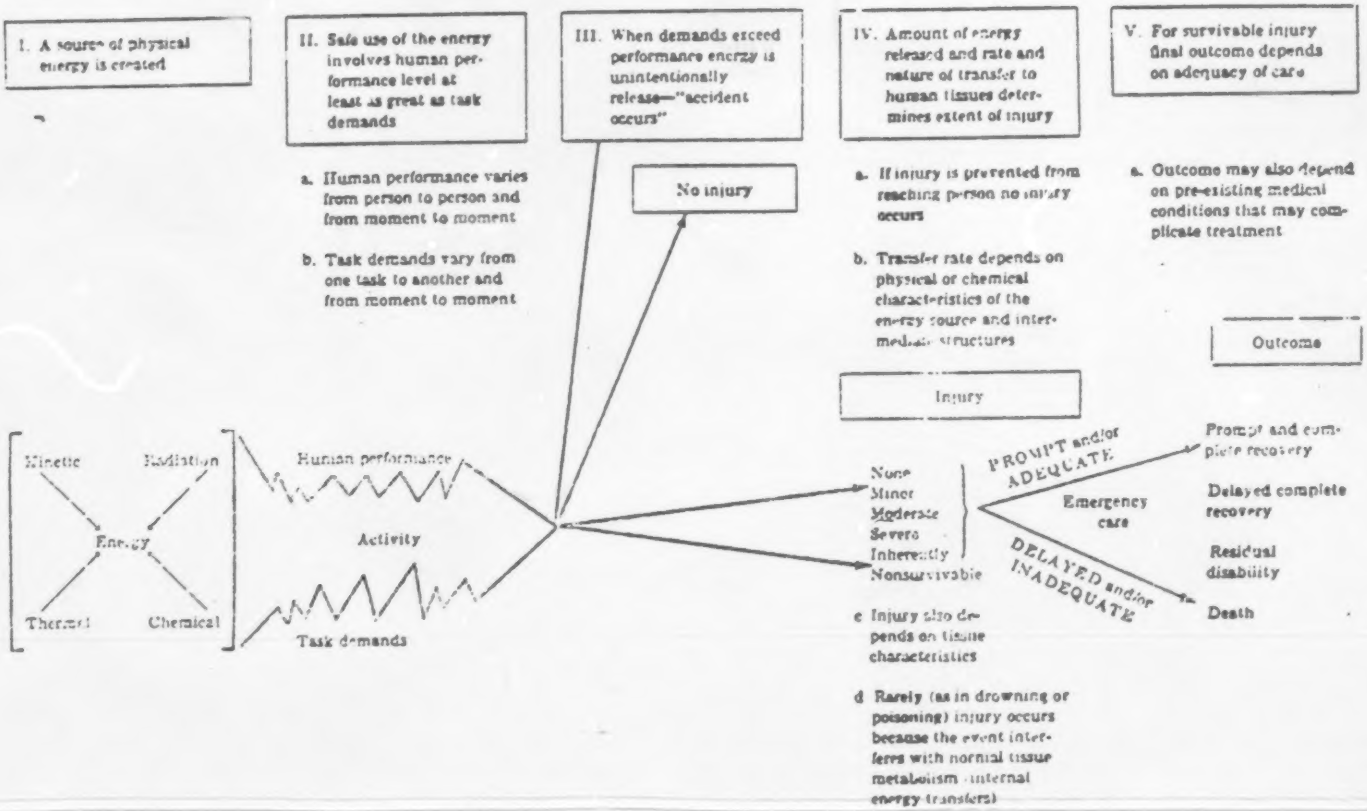
I. A source of physical energy is created
II. Safe use of the energy involves human performance level at least as great as task demands
III. When demands exceed performance energy is unintentionally release—"accident occurs"
IV. Amount of energy released and rate and nature of transfer to human tissues determines extent of injury
V. For survivable injury final outcome depends on adequacy of care
a. Human performance varies from person to person and from moment to moment
b. Task demands vary from one task to another and from moment to moment
No injury
a. If injury is prevented from reaching person no injury occurs
b. Transfer rate depends on physical or chemical characteristics of the energy source and intermediate structures
a. Outcome may also depend on pre-existing medical conditions that may complicate treatment
Outcome
Injury
Kinetic
Radiation
Energy
Thermal
Chemical
Human performance
Activity
Task demands
None
Minor
Moderate
Severe
Inherently
Nonsurvivable
PROMPT and/or ADEQUATE
Emergency care
DELAYED and/or INADEQUATE
Prompt and complete recovery
Delayed complete recovery
Residual disability
Death
c Injury also depends on tissue characteristics
d Rarely (as in drowning or poisoning) injury occurs because the event interferes with normal tissue metabolism (internal energy transfers)

Figure 2
A model for the occurrence of injury and its outcome. (Waller, 1972:34)

categories of countermeasures as approaches to injury control based on the 3 phases of the injury event and on human, vector, and environmental factors. Broad categories of countermeasures are: changing the environment, making tasks less demanding, strengthening individuals, and providing adequate emergency treatment. There are some general considerations in the selection of injury countermeasures: 1) Priority should be given to those measures that will most effectively reduce injury frequency and severity. Experience has shown that efforts directed at communities, not individuals have most potential (Barry, 1975); 2) Multiple strategies should be employed, with measures addressing each of the three phases of the injury sequence; 3) Higher value should be placed on passive or automatic measures, that is, those that don't require the participation of individuals. Sprinkler systems, for example, are more effective fire protection than hand-held fire extinguishers. 4) Societal acceptability is important, with particular attention to the quality of life for older people.

Lawton and Nahemow (1975:657) proposed an ecological theory of adaptive behavior and aging, a transactional model to help explain relationships between aging individuals and their environments. Although that model has to do largely with social environment, it was derived from Helson's adaptation level concept for psychophysical phenomena; along with the Haddon and Baker strategies above, it can help us focus on classes of questions to raise about why the elderly, or better still, different subgroups of older people, are at differential risk for injury. Such a model can also suggest approaches to injury control. Components of the Lawton-Nahemow model that are useful for our purposes are: degree of competence (a diverse collection of abilities of the individual, including mental and physical health, abilities which are related to ability to perceive and respond, and differences in injury threshold), environmental press (objective forces in the environment that are defined as positive or negative by the individual) including amount and type of to risks adaptive behavior (the outward manifestation of individual competence), and adaptation level (the zone of maximum performance potential or spare capacity) Individuals of high competence have a wide latitude of capacity to interact with the environment in ways that maximize adaptive behavior. Put another way, persons with deminished competence have maladaptive responses (outside their adaptive range) to relatively slight degrees of environmental press.

The remainder of this paper with address the three main injury events for the elderly: fall injuries, motor vehicle injuries, and fires and burns. The treatment is uneven, mainly because of the variable quantity and quality of available epidemiologic data. Except for road crashes there is no standard method or requirement for reporting frequency and severity of non fatal injuries. There is very little epidemiologic data on the non-fatal consequences of injury to older people. In data that are collected there is evidence of considerable underreporting. Exposure data are hardly ever available. Elderly people sustain most of their injuries in their homes--not necessarily because their homes are not safe, but probably because they spend so much of their time at home. There are several well designed epidemiologic studies and several surveys that help us understand differential or death rates.

Injuries that are deliberately self-inflicted or that result from interpersonal violence to others (suicide and homicide) are classified as intentional injury. In this paper the term injury will refer to unintentional injury though some data sources do not separate the two. Although intent doesn't change the injury, can often not be determined, and in many instances is irrelevant to prevention, comparable estimates of magnitude are sometimes frustrated by lack of consistency with respect to intention.

Falls

Data

The actual incidence of falls is unknown because only those fall injuries receiving medical attention, usually in emergency rooms, are likely to be recorded. No standard forms are used for those that are recorded. Most published studies are retrospective; even those with controls are not population based and do not report falls that don't receive medical care. Appropriate exposure data are rarely available. There is semantic confusion about the word "fall", and lack of agreement on types of falls. Unlike thermal injury, the etiology of falls is often not known. Suicides may be enlarging the category of unintentional injury. Studies which link death certificates and medical records show that falls are often not listed on the death certificate, especially for older people.

In this section we will refer to Underlying Cause of Death Statistics for the United States for the years 1969 and 1975, to data published by the National Safety Council in Accident Facts, 1980 Edition, and to a series of studies known as the Washington State Falls Study for estimates of the seriousness of fall injuries as a health problem for the elderly. To shed light on the natural history of falls, circumstances surrounding their occurrence, and their consequences for the elderly we will selectively review a five year prospective study of falls in an active, ambulatory, institutionalized population over 65. A case-control study of 150 persons age 60 or older who were treated in an emergency department for injuries from falls, and a study of falls on stairs. We will refer briefly to numerous additional findings.

Magnitude

For all ages combined, the death rate from falls has gradually dropped from a high of nearly 20 per 100,000 in the mid 1930's to 6 in 1977 (National

Safety Council, 1980: 8). Over the decade 1969-1979, for all ages combined, deaths from falls declined 27%, from 17,827 to 13,000 (National Safety Council, 1980:20) Part of that decline is due to changes in methods of classification with revisions of the International Classification of Disease. Both injury and death rates for falls are higher in urban than rural areas. The States with the highest age-adjusted death rates for falls are with in New England; Hawaii and Mississippi have the lowest. (Iskrant and Joliet, 1968). Persons 65 or older account for more than 70% of the deaths due to falls, having both a higher than average number of falls and a high case fatality rate. More than half the deaths due to unintentional injury in people 65 and older are due to falls. Table 7 shows the comparitive frequency and rates of death from falls for all age groups.

Table 7 Deaths From Falls, by Age Groups For the United States, 1977

	Number	Rate per 100,000
All ages	13,773	6
Under one	121	1
5-14		
15-24		
25-44	956	2
45-64	2245	5
65-74	1995	14
Over 74	7,762	87

Source: National Safety Council, Accident Facts, 1980 Edition, p 8
(Excludes Falls in or from transport vehicles)

Examination of death rates due to falls in 1969 and 1975 for the U. S. yield interesting findings when the two older age groups are considered separately by race and sex. The death rate due to falls has dropped in all

65 years and older categories from 1969 to 1975 (Table 8). It has been commonly believed that death rates due to falls are higher in women than men, probably because of awareness of the high frequency of falls in older women. In 1969 women of all races 75 and older did have higher rates; that was not true in 1969 for the 65-74 age group, where men of all races had substantially higher rates than women (Table 9). Note the 5 fold increase in death rates for white males 75 and older compared to white males 65-74; the parallel non-white male increase is only a factor 2.6. That may help explain some of the crossover effect [3] in white males compared to non-white males at 75 years and older (Manton, Poss, & Wing, 1979). The same phenomenon exists in 1975 data.

In 1975 male death rates due to falls are higher in both the older age groups and in all races. Within both 1969 and 1975 white and non-white rates are quite similar in the 65-74 years groups, but in persons 75 or older, there is a marked racial differential, with white rates more than double non-white rates. In an effort to uncover possible explanations for the white excess in the 75 and older group, we looked at death by types of falls by race and sex in that age category. The numbers are extremely small, but there is a suggestion that non-whites die from falls on stairs at lower rates than do whites.

In the Washington State Falls Study, Hongladarom (1977:160-165) discovered, in a review of 1975 death certificates for the State of Washington that in 117 of 3,949 deaths that came under the jurisdiction of the medical examiner, the recorder mentioned a fall injury that preceded the death but these were not coded to the E880 (injury series). Over 91% of these 117 were age 65 or over. The investigator concluded that fall injury deaths are selectively underreported in the elderly.

Table 8. Death Rates Per 100,000 Population Due to Falls in Persons 65 and Older, by Race and Sex; United States, 1969 and 1975.

	1969	1975	% Change
65-74 Years			
White Males	27.3	20.2	- 25.6
White Females	17.1	11.9	- 30.4
Non White Males	24.1	22.6	- 6.2
Non White Females	16.2	10.1	- 37.7
TOTAL 65-74	21.4	15.5	- 27.6
75+ Years			
White Males	136.0	108.8	- 20.0
White Females	149.7	102.4	- 31.9
Non White Males	62.5	47.2	- 15.3
Non White Females	66.7	43.4	- 34.9
TOTAL 75+	138.5	99.8	- 27.9
TOTAL 65+	62.3	47.6	- 23.6

Table 9. Death Rates Per 1000,000 Population Due to Falls in Persons 65 Years and Older, by Race and Sex; United States, 1969 and 1975.

	1969	1975
65-74 Years		
Males	27.0	20.5
Females	17.1	11.7
White	21.6	15.5
Non White	19.8	15.7
75+ Years		
Males	136.0	103.2
Females	149.7	100.4
White	144.4	104.8
Non White	65.0	44.9

One phase of the Washington State Study was analysis of 1,740 fall injury cases treated in the Yakima Valley Hospital Emergency Department during 1975. In that study "more than fifty percent of the fractures treated occurred to individuals over fifty years of age whereas 64.3% of the intracranial injuries treated occurred to individuals fourteen and under, (Hongladarom, 1977; 36).

It appears that women have higher fall rates and not just greater frequencies because they outnumber men. In the Baycrest study (Gryfe, Amies, & Ashley, 1977), the 68% of residents who were female had 76% of the falls. When older people fall, fracture (rather than laceration or head injury) is the most common injury. Femurs, then radius-ulna, then hips are the most prevalent types of fractures in old people. (Hongladarum, 1977) Another aspect of the magnitude of fall injuries is disability incurred. Days of hospitalization were reviewed in the Yakima Valley Hospital phase of the Washington State Study. In that study persons over 60 had 23.5% of the fall injuries treated, but they had 1,500 days of hospitalization, over 80% of the total days of hospitalization (Hongladarum, 1977;48).

Developmental and Other Human Factors: Environments

Although DeHaven's study (1942) of survivors of falls from heights marks the beginning of the modern field of injury control, the study by Sheldon (1960), "On the National History of Falls in Old Age" is a classic. Sheldon described the phenomen of drop attacks, with no aura, no amnesia, no tripping. Twenty-five percent of the 500 falls he studied were drop attacks. In a study of 384 elderly people with fractured femurs Brocklehurst et al. (1978) classified types of fall as tripping, loss of balance, drop attack, and other. Younger (65-74 yrs.) patients were more likely to have tripped, while drop attack was more common in those 75 and older. Isaacs (1978) concluded that the common factor in drop attacks was "the lack of any other obvious cause, and that attributing a fall to loss of balance is similar to attributing windowhood to loss of a spouse. Isaacs proposes that falls be classified according to the activity being undertaken, such as posture change, walking, etc. (Isaacs also describes neurological processes involved in falls, a distinct departure from the observations of Sheldon and those who have adopted his classification).

Gryfe, Amies, and Ashley (1977) conducted a five year prospective study of the falls of 441 residents of the Jewish Home for the Aged within the Baycrest Centre for Geriatric Care in Toronto. The subjects, 68.7% female, were all over 65, (73% were 75-90 years), resided in a 10 story apartment building which was similar to ordinary community living except that there were no stairs, and within individual dwelling units, no stoves. To be admitted, residents had to be independent in activities of daily living. 44.9% of the subjects experienced at least one fall during the average observation period of 2.2 years. Women had over 75% of the falls. In 40, or 6% of the falls there were fractures. In 353, or 54%, there was no injury observed. The average number of falls for those who fell was 3.3. The overall rate of falls for both sexes was 668 per 1000 per year. In women, the proportion of severe injuries increased with age. Twenty-two of 34 residents who had six or more falls died by the time the first report was published; twelve of those subjects appeared to have a clustering of falls just prior to their death. Rodstein thought that "accidents in the aged may be manifestations of the onset of acute disease" (1964:516), and Hongladarom (1977:67) found new health problems following the injury event in 6.8% of the 1,662 people (all ages) treated for fall injuries in the Yakima Valley Hospital study. While those figures can't be readily evaluated because of lack of similar observations in appropriate controls, they might offer a clue to be pursued in future research.

The reverse situation, that is, that acute or chronic health problems contribute to falls, has been studied more, notably by Waller (1972; 1978), in a study of non-highway deaths in persons 15 years or older, Waller compared the blood alcohol levels of persons who died as a result of falls (and other injuries) with blood alcohol concentration of persons who died of chronic disease. The numbers of injury subjects and data on elderly subjects are inadequate for conclusions for our purposes. In a more recent study of 150 persons aged 60 or older treated in an emergency department for injuries from falls, Waller (1978) built a matched control group of 150 elderly neighbors not known to have injuries. He found that in 42% of the treated falls were precipitated by an acute or chronic health problem including misuse of alcohol. Data presentation precludes ascertainment of a comparable rate for control subjects. An additional word of caution about studies of "cases" which come to medical attention is that "cases" which do not come to medical attention are represented neither by control subjects nor those defined as cases. In a study of 71 elderly patients with fatal internal cerebral injury, Kirkpatrick and Pearson (1978) concluded that "falls... were often precipitated by physical illness or ingestion of alcohol," but their report is more anecdotal than epidemiologic, with no comparative data. In the Brocklehurst et al study (1978), compared to same age controls, the older fracture patients had a higher prevalence of chronic brain syndrome, were in poorer physical state, and their skinfold thickness was less, and they had more visual impairment. Those who were younger had a higher prevalence of stroke than comparable controls. "Sway," or postural instability, intermittent cardiac dysrhythmia, and impaired cerebrovascular perfusion have been implicated as internal causes of falls, but those findings accumulate from clinical observations, not controlled. (See Witte, 1979, for a good summary of physiologic factors related to falls) In several studies of falls or fractures in old people the youngest patients in the series have considerable medical comorbidity. Macdonald and Macdonald (1977) studied relationships between falls of 390 elderly women with femoral fractures, and their barbiturate use. They found that of the 98 who fell between 10 p.m. and 6 a.m. that 93% were taking barbiturates. Only 6% of the 217 women who fell between 6 a.m. and 2 p.m. were on barbiturates, and none of the 75 patients who fell between 2 p.m. and 10 p.m. took barbiturates. Similar, but far less dramatic results were found when overall hypnotic use was considered.

Svanstrom (1974) interviewed 273 children and adults who fell on stairs in Malmo, the third largest city in Sweden. 76% were going down stairs when the fall occurred, Svanstrom cited evidence that in ascent "the foot is lifted only 1 or 2 cm above the riser." In his examination of stairways, however, the risers varied by more than 2 cm in almost 40% of those measured. In a related study Svanstrom found that U-shaped, two-flight stairs caused substantially fewer accidents than straight, single-flight stairs.

Gelwicks and Newcomer (1974) have described planning housing environments for the elderly with suggestions for helping residents negotiate environments safely and with a sense of competence. Carp (1976) recommends involving older persons in the design of housing. There is some evidence that older people tend to fall in environments that are new to them. For example, in a study of 511 elderly men and women in a hospital, 134 of them fell during the 33,014 bed days of the study (about 35 weeks study duration). Over 60% of the falls occurred during the first week. (Sehested & Severin-Nielson, 1977). Tinker (1979) reports a similar finding--45% of the falls in a 10 weeks prospective study occurring during the first week in a genetic assessment unit.

Not mentioned before, but of extreme importance in the consideration of falls in late life is the problem of osteoporosis. In a superb review of basic and clinical research on osteoporosis, Marx (1980:628) states that as many as 190,000 elderly Americans suffer broken hips each year. One sixth of them die from complications, and many survivors are disabled. Osteoporosis, present in most of those broken hip victims, subjects bones to fracture by stresses that would not break normal bones. Marx cites Heaney, a leading investigator in the field, who says that "About 25 percent of all white women have had one or more fractures by age 65." These fractures include, in addition to the broken hips, about 100,000 broken wrists every year. Vertebral fractures, or crush fractures are a common feature of osteoporosis. The death and disability caused by osteoporosis is accompanied by other expenses: Riggs of the Mayo clinic estimates the cost of acute medical care for elderly patients with broken hips is more than $1 billion each year (cited by Marx, 1980:628) Although many have considered osteoporosis an inevitable consequence of aging, especially for White and Oriental women, evidence from experimental therapies for slowing bone loss is beginning to point toward prevention of osteoporosis. Everyone begins losing bone mineral at around 40 years of age, and for women, bone loss accelerates at menopause. The high rate of loss continues for about 20 years, during which women lose .5 to 1.5% of their peak bone mass every year. Although it has been known since the 1940's that menopause predisposed women to osteoporosis, direct proof that estrogen can slow bone loss did not begin to accumulate until about 10 years ago. Only within the past 5 years has the mechanism of that relationship been clear. Overall, Marx writes (1980: 629), "the work of the Heaney and Riggs groups suggests that estrogen deprivation leads to increased sensitivity of bone to parathyroid hormone PTH, causing increased dissolution of bone mineral and elevated blood calcium concentrations, which are followed by decreased secretion of PTH and decreased calcium absorption. The theory helps to explain why bone losses increase as people age and, especially, why women lose calcium faster than men. But it does not explain why some women develop the fractures of osteoporosis and others do not." Basic research is still needed to help explain the relationship of two competing processes: bone resorption and formation. The etiologic research has given clinicians new ideas for therapies. Although estrogen therapy, even for 2-3 years, is controversial because of the risk of uterine cancer, and newer agents such as calcitonin, stanolozol, and a vitamin D derivative called 1,25-dihydroxyvitamin D are relatively untested, all appear to have some merit. Somewhat more controversial is fluoride and calcium therapy. Individuals have been treated with the combination in a recent clinical trial with encouraging reductions in expected fractures in those with X ray evidence of increased bone density but with serious side effects. Elsewhere Hegsted (1968) writes of evidence of fewer fractures of the spine among people who live in areas with at least 3 ppm of fluoride in their drinking water. Marx (1980:630) cites work by Whedon suggesting that because inactivity can hasten calcium loss, that physical activity be maintained. Whedon and Heaney also recommend that postmenopausal women increase their calcium consumption to 1000 to 1500 milligrams daily, the equivalent of 1 to $1\frac{1}{3}$ qts. of milk.

Waller (1975) has reported that young people preferentially receive emergency care. Elsewhere (Waller, 1978) thereis evidence that injured elderly persons are alone at the time of the event--even in residential institutions someone was not available 14% of the time. Two thirds of the time the fall victims in Waller's 1978 report had no first aid given, even for fractures of the back and long bones. Waller also noted (1978:30) that it was not uncommon for the older injured person to wait at least an hour, sometimes 6 hours, before *seeking* help.

Countermeasures

In addition to measures noted above for the prevention of osteoporosis, there are a variety of environmental measures to be considered. Haddon and Baker (1980:25 in pre-print draft) write "the problem of injuries and their sequelae among the elderly requires action by the several professions in a position to contribute to its solution. Environments must be made more negotiable and less hazardous. Floors must be free of irregularities and loose rugs; stairways and bathrooms must have handrails; shoes must have low, broad heels; and the help of capable people must always be accessible. Measures must be taken that attenuate the forces of impacts: Padded rugs accomplish this to some extent, although care must be taken that the type, condition, or placement of rugs does not increase the likelihood of tripping. Ironically, New York State has long required that boxing rings have floors of energy absorbing material to reduce injury to falling pugilists. The elderly, especially when concentrated in hospitals and nursing homes, deserve the same consideration for both humanitarian and economic reasons."

Additional research

Obviously more research is needed to unravel more of the osteoporosis mystery to establish the best possible preventive and, if possible, treatment strategies. Better morbidity data might identify more countermeasure strategies, and there might be some merit in learning why older women have higher fall and fracture rates but older men have higher death from falls rates.

Motor Vehicle Crashes

Data

Compared to other kinds of injury in the elderly there is quite a bit of information available about road injuries. In this section we will use data from the National Safety Council (Accident Facts, 1980 Edition), Underlying Cause of Death Statistics for the United States for 1975 and 1969; age and sex specific death rates for recent years for one state (North Carolina); Current Estimates from the Health Interview Survey, United States, 1978; and findings from several studies of aging drivers. Mileage estimates are available from the Department of Transportation. The reader is cautioned that definitions for motor vehicle injury or death vary across data sources.

Magnitude

When miles driven are considered, the elderly, especially those over 74, have high injury rates and extremely high fatality rates. Pedestrian deaths are substantial.

There are 13.3 million licensed drivers 65 and older. They represent 9.3% of all licensed drivers in the United States (National Safety Council, 1980: 54). The proportion of drivers 65 and older is rising in spite of tightening of reexamination requirements in many states. The proportion of female drivers decreases sharply with age when cross sectional data are reviewed; that pattern is changing. Female older drivers are increasing in greater numbers than males. It is anticipated that by 1985 there will be an increase (compared with 1972) of 129% in the number of female drivers over 64 and only an 18% increase for males (U.S. Department of Transportation, 1975). Older drivers drive less. Planek (1972) reports that "drivers in their fifties begin to show a decrease in annual miles driven that continues steadily in later years." Opposing conclusions have been drawn about the safety of older drivers. It is true that older drivers have a relatively small number of crashes; it is also true, however, that older drivers have a higher crash rate than any group except the under 25 age group if miles driven or exposure is taken into account. Table 10 gives an indication of driving experience by age and exposure.

Table 11 does not take miles driven into account, but shows numbers and rates of motor vehicle injury and ratio of injury to death, by age, with extremely high death rates of the elderly. Men have disproportionately high death rates from motor vehicle crashes compared to women. They also have more injuries though the difference is smaller. Waller (1980a:1560) points out that while miles driven, type of driving, and alcohol ingestion might explain these gender differences partially, they are not a complete explanation. Waller noted that "males have higher injury rates starting very early in life, over a wide range of activities, and that this pattern is reversed only in two instances; fire injuries are more common among little girls than boys...and elderly women have higher rates of fall injuries than do old men."

In 1975, nearly 5.6 thousand people 65 and older died of vehicular crashes. That represents 12.3% of such fatalities for all ages, and 28% of all injury fatalities for people 65 and over. Eighteen hundred, or nearly a third of those vehicular crash fatalities were pedestrian deaths. Of interest in those data is the experience of men 75 and older. In 1969 the death rate of white males 75 and older remain lower than those of non-white males. That is, there is no crossover. Furthermore, death rates of non-whites of both sexes and in both those age groups increased from 1969 to 1975.

The 55 mph national speed limit in 1973 was accompanied by lower motor vehicle death rates at all ages, but Figure 3 shows that the decline from

1973 to 1974 was greatest in the two groups aged 65 and older, and that in the subsequent 5 years those two age groups were the only ones whose death rates didn't increase. Data to adjust for miles driven are not available, and a variety of interpretations is possible, including inflation and especially high fuel prices differentially affecting the elderly (further limiting their mileage), and a greater law-abiding tendency of the elderly. Motor vehicle death rates for age and sex for North Carolina for 1972 through 1976, also not adjusted for mileage, show the great excess in male mortality at all ages for nearly all years. (Table 12) We see in this table that in North Carolina death rates for women 75 and older did not decline after 1973. North Carolina motor vehicle death rates are slightly higher than U.S. rates. For example, in 1978, in North Carolina there were 3.6 deaths per 100,000,000 vehicle miles, for the U.S., 3.3. (National Safety Council, 1980; 63).

What do we know about the characteristics of vehicular crashes of older drivers? In a study of 354 male and female white drivers aged 46 to 71, who were panelists in the Duke Adaptation Study (described elsewhere) (Palmore, 1974), the descriptive findings are similar to those reported for older drivers in other studies. Motor Vehicle Department records for a 3-year period were examined; Adaptation study data on physical health, psychological and social characteristics were also studied. For the 3-year period, slightly more than 15 percent had one or two crashes. That incidence yields for one year an average rate of 0.056, which compares favorably with the North Carolina rate of 0.063 for drivers 45 and over for a concurrent year (U.N.C. Highway Safety Research Center, 1974). Only 16 percent of the drivers in this study (28 percent of the men and 3 percent of the women) estimated their annual mileage at 15,000 or more. There was no association between crashes and estimated miles driven, but more than one-third of the crash drivers said

Table 12. Motor Vehicle Death Rates per 100,000 Population, by Age and Sex, for North Carolina, 1972-1976.

MALES

Age	'72 Rate	'73 Rate	'74 Rate	'75 Rate	'76 Rate
Under 5	14.4	16.6	13.0	10.8	9.4
5-9	21.4	20.2	15.1	15.1	15.5
10-14	16.6	18.9	14.3	16.6	17.0
15-19	86.1	90.6	82.8	72.8	84.9
20-24	117.1	107.0	83.8	90.1	86.3
25-34	78.0	64.8	60.0	63.2	62.5
35-44	47.6	47.9	48.6	44.8	39.8
45-54	52.3	46.3	42.6	39.7	38.9
55-64	58.6	59.6	50.1	37.7	48.6
65-74	84.1	76.3	49.1	54.3	38.6
75+	80.5	94.8	60.8	71.6	88.7
Totals	57.1	54.7	46.6	45.3	45.9

FEMALES

Age	'72 Rate	'73 Rate	'74 Rate	'75 Rate	'76 Rate
Under 5	7.5	13.5	12.6	12.6	8.4
5-9	11.5	13.2	12.8	8.2	8.7
10-14	12.5	10.2	5.5	4.7	6.3
15-19	32.0	29.2	24.8	22.0	27.6
20-24	20.3	17.6	20.3	13.1	20.3
25-34	21.1	16.8	15.9	15.9	17.8
35-44	19.3	12.8	9.8	12.8	11.5
45-54	18.5	19.8	14.0	13.7	13.7
55-64	22.1	22.5	15.3	11.9	14.0
65-74	29.8	25.3	19.4	16.2	21.4
75+	34.6	22.3	23.4	25.6	25.6
Totals	20.1	18.2	15.3	13.7	15.1

Source: N.C. Highway Safety Research Center they drove less than 6,000 miles per year. None of the crashes occurred between 9 p.m. and 7 a.m., and 81 percent occurred between 7 a.m. and 6 p.m. Only 12 percent of the crashes took place in rain, and none in snow. Eighty-two percent of the 56 crashes took place in the driver's home county and an additional 7 percent in the adjacent county. Most (79 percent) occurred in business or residential sections. Twenty-nine persons were injured in 14 crashes; there were no immediate or delayed fatalities. All but two crashes involved two or more vehicles. The predominant error recorded for these crashes was disregarding a stop sign or traffic signal or failing to yield (25 percent). Only one driver was charged with excessive speed associated with a crash. In only 2 of 56 crashes was the driver noted to be under the influence of alcohol with ability impaired. In this study no association was found between vision, hearing, cardiovascular or musculoskeletal impairment, general functional status, life change or coping resources and road crashes (Hogue, 1974).

Developmental and other human factors; environments

Features of normal aging which are important to consideration of the driving task include the general areas of sensory reception, neural processing and transmission, and motor response. Planek (1972) reviews literature which documents narrowing of the visual field beginning in the late thirties, the need for increased illumination rising with age, glare sensitivity increasing beginning at about age 40, and the rate of dark adaptation decreasing with age. Allen (1970) describes visual aspects of driving in great detail. Studies which have attempted to bridge the gap between laboratory findings and actual driving performance are scarce and have had conflicting results (Burg, 1967; Crancer, 1969). Pastalan studied a small number of elderly drivers in systematically designed driving situations by videotaping their performance and interviewing them afterward. In another phase of the study, staff members of the Institute of Gerontology were driven through the test route as front seat passengers wearing empathetic lens eye glasses to simulate typical vision of a person in her late seventies. Problems related to glare, color distortion, backlighting, and depth perception were described, as well as issues related to attention, information overload, and decision making were reported by Pastalan with his suggestion for further research (Pastalan, 1977). Planek (1972) cites research showing deficits in short-term memory, visual discrimination, and logical interpretation of stimuli, speculating that those deficiencies probably affect driving. Waller (1980b) states that at least in part due to decrements of normal aging, many older drivers limit first their nighttime and high stress driving and then all driving.

Medical conditions common among the elderly have been studied in relation to driving. Waller (1965; 1977) found that drivers known to have diabetes, epilepsy, cardiovascular disease, alcoholism and mental illness averaged twice as many crashes per 1,000,000 miles of driving as did control drivers with no known disease (data age adjusted). Crancer and McMurray (1967) on the other hand, found no excess of crashes among drivers with a heart disease license restriction; they did find higher crash rates for drivers with epilepsy, fainting and other medical conditions at all ages. Planek (1972) cites work by Grattan and Jeffcoats using British and Swedish data showing incidence ratios of only one in 1,000 crashes associated with sudden illness. In the Baker and Spitz (1970) study of fatally injured drivers arteriosclerotic heart disease by autopsy was found with similar frequency in those drivers who were found at fault and those who were not. Waller (1977:395) suggests that if we "want a true picture of the contribution of medical impairment to highway crashes we must include not only those relatively few persons who have obvious clinical episodes" (fatal or not) behind the wheel but others with the same medical condition but do not have such episodes. Although alcohol is a very important factor in crashes of drivers under 65, it isn't clear at this time that alcohol-related crashes are prevalent in older drivers. Nonetheless, older people should be warned about alcohol-drug interaction, and that driving may be impaired by amounts that would not have so affected them when younger.

We've noted earlier that older drivers who are injured have high fatality rates. When Baker and Spitz (1970) examined autopsy and police records of 328 fatally injured drivers, they found that the proportion of drivers 60 years or older was five times as high among those killed as among drivers who survived crashes, and further that "delayed death" was more common among older drivers and was associated with less serious injuries than in younger drivers.

There were 9,400 pedestrian deaths in 1979; over 20% of those killed were 65 years old or older (National Safety Council, 1980:42). The death rate is much higher for males than females and slightly higher for non-whites than whites. In a classic study of pedestrian injuries by Haddon and others (1961), those who were injured and killed were on the average, 10 years older than those injured who survived. Also, elderly people were more likely to be hit by cars than younger pedestrians even when exposure was similar (Haddon et al, 1961. Carp (1971a:105) pointed out that "the visual-motor changes and the increasing incidence of health problems which limit vehicular transit for older people serve also to inhibit pedestrian travel." The great majority of elderly pedestrians who are injured and killed are struck at intersections (children are much more likely to be struck between intersections) (National Safety Council, 1980:55). Waller (1980b) noted that people can't walk as fast after about the age of 60 when the center of gravity shifts forward and they look down as they walk. "Looking at traffic, and especially at traffic lights above eye level, is difficult for them. The current rules for cycling of traffic lights and pedestrian activated buttons," Waller writes (1980b:8), "assumes that people walk at 4 ft/second....that is not adequate for the elderly."

Compounding these problems for elderly drivers and walkers is great need for transportation among older people. In one needs assessment after another (Duke Center for the Study of Aging, 1978; Branch, 1980) and indeed emphasized in the 1974 White House Conference on Aging, transportation is cited as the most important need after money and health. It is important for goods and services, and as an indicator of independence and self-sufficiency (Carp, 1971b; Ashford and Holloway, 1972.

Countermeasures

Driver education has been a traditional approach to reducing road crashes, and as evidence of the greater crash involvement of elderly drivers and of the ability of older people to learn new skills has accumulated, driver education has been suggested for the older driver. A program called "55 Alive/Mature Driving," jointly sponsored by the National Retired Teachers Association and the American Association of Retired Persons, was begun in the late 1970's. The curriculum consists of two three and one-half hour sessions in two days, is taught by volunteer instructors, aged 55 or older, trained for three days. The new program was begun in California, Florida, Illinois, and Virginia with more than 10,000 drivers participating. Goals include updating driving knowledge, sharpening skills, and keeping older drivers on the road longer (Seaton, 1979). Although the program is enthusiastically supported by its sponsors and at least one insurance company has agreed to give up to 10% discounts for three years to those who complete the course, the program evaluation being conducted by the National Highway Traffic Safety Administration has not been concluded. While it is commonly believed in our society that educating people about their problems and abilities to handle them can solve most of those problems, research evidence often does not support that assumption. "Engineering for people rather than trying to engineer people by changing their behaviors has the better record of success" (Robertson, 1980:13). Injury control programs that automatically protect people without their having to take any action (Haddon and Goddard, 1962) are most successful. Barry (1975:54) argues for a shift in focus from the individual to the community for reduction in incidents leading to injury and reduction in the severity of those injuries which do occur. Haddon and Baker (1980:8) suggest a combination of approaches.

Measures that are more likely to improve injury control for all, but especially for high risk groups such as the elderly include improved vehicular and roadway design (with attention to greater use of energy-absorbing materials, decrease of vehicular obstacles to vision; more visible dashboard features; better road illumination; larger stop, yield, and route guidance signs; separation of pedestrians from moving vehicles by such means as underpasses (Wiener, 1972), removing fixed object roadside hazards[4]), better emergency medical care (with systems that encourage treatment of particular injuries by those most competent to handle them (Franklin and Boelp, 1980), and improved health care (including periodic review of pharmacologic agents, both prescribed and not prescribed; prevention of osteoporosis, etc.), improved public transportation and city planning (including designing of vehicles which even impaired elderly can negotiate).

One issue that evokes strong emotion for opposing reasons is the matter of restricting driver license. Few suggest restriction on the basis of chronological age, but many encourage application of guidelines to restrict impaired older drivers with cardiovascular disease or impaired mental status (Waller, 1973). At this time evidence supports individual counseling by health care providers and not systematic restriction by licensing agencies. Numerous studies have shown that older drivers voluntarily limit their driving (Ysander and Herner, 1976; Mourant and Mourant, 1979; others cited above). Furthermore, we would need to restrict an enormous number of drivers to achieve even small gains. Haddon and Baker (1980:17) estimate that even if drivers with a particular condition were to have twice as many fatal crashes as non-affected drivers, prevention of one such additional crash would necessitate identification and restriction of about 3,000 drivers with the condition, based on the current ratio of about one fatal crash per year for every 3,000 licensed drivers. Regular medical exams are probably worthwhile for professional drivers.

Research

Perhaps additional documentation of the relationship of perceptual decrements and medical conditions is in order. Beyond that, further research should have more payoff than has the documentation of high risk groups in the past. For example, research leading up to reducing the complexity of the driving task might be worthwhile. That would first require studies in test driving or simulator conditions to describe the driving task for older persons of varying characteristics. As the number of older women drivers is increasing, they should be included in such studies. While longitudinal studies are less likely now than in the past, it would be advantageous to have longitudinal data on drivers in middle and late life. Finally, the consequences of crashes and limitation of driving for the elderly need to be studied.

Thermal Injuries

Data

Data on burn injuries come mainly from hospital-based studies, national surveys, and vital statistics reporting cause of death. While those different sources of information are useful in describing the problem of burns and their sequelae, there are limitations inherent in the data. Studies on patients from a single hospital are useful in assessing quality of care, or therapeutic techniques, but not important in describing the magnitude of burns nor in contributing to our understanding of the factors which are associated with burn injuries from an epidemiologic perspective. Those studies tend to overrepresent the more severely injured; they exclude those with minor burns and those who die before arrival at the hospital. In addition to those "numerator" problems, the population base or "denominator" is unknown. Survey data such as the National Health Survey are clearly defined and are representative of the United States population, but "burn injuries" are not separated from "other injuries" in that reporting system. Those data sources will not be included in this report. If more states considered burns a reportable health problem (as does the State of Massachusetts) we would have a more accurate description of at least the incidence of burns. The best data available at this time for our understanding of burn injuries in the elderly come from a regional burn survey, from the National Burn Information Exchange (NBIE), Underlying Cause of Death Statistics (100% sample) for the United States for 1975. The New York Burn Study (Feck and Baptiste, 1979; Feck, Baptiste, and Tate, 1978), is an intensive study of all burn injuries for two consecutive years resulting in admission of the injured for at least one day to a hospital in upstate New York. The New York study included all of New York State except New York City, a population of 10.75 million, 223 hospitals, and 5,791 inpatients with new burns. The NBIE, founded in 1964, provides data on more than 40,000 burn-injured persons treated in 133 specialized burn care facilities in the United States and Canada. Findings from several other studies will round out the presentation.

Magnitude

Thermal injuries include 1) burns and toxic inhalations resulting from conflagration or residential fires and from clothing ignition, 2) contacts with hot surfaces or substances not involving open flames, including scalds, and 3) electrical burns. The first two categories are important for the elderly.

The very young, the elderly, and the poor are disproportionately burdened by burns. The incidence of new burns that require hospitalization is about 27 per hundred thousand population each year,[5] with peak rates of 74 for children under five, and rates of 28, 37, and 41 for persons 75-79, 80-84, and 85 and older (Feck, Baptiste, and Tate, 1978) Barancik and Shapiro (cited in Feck, Baptiste and Tate, 1978:6) reported that "burn injuries treated in hospital out-patient departments or emergency rooms were about 10 times as frequent as admissions for burns. The rate of burn injuries for both black and white males is higher at every age group, though the excess is somewhat less dramatic among infants and the elderly. Although the rate of hospitalization for burns for blacks of all ages is 66 per hundred thousand annually, nearly three times that in the white population (Feck, Baptiste, and Tate, 1978), it appears that the black excess is far greatest among young children. In the New York Burn Study the lowest burn incidence rates were in the three counties with the highest socioeconomic status (Feck, Baptiste, and Greenwald, 1977), and in the population based Montreal home fires study the census tracts with the highest incidence were those with a predominance of old houses with inhabitants in low income brackets (Ducie & Ghezzo, 1980:69), Ducic and Ghezzo

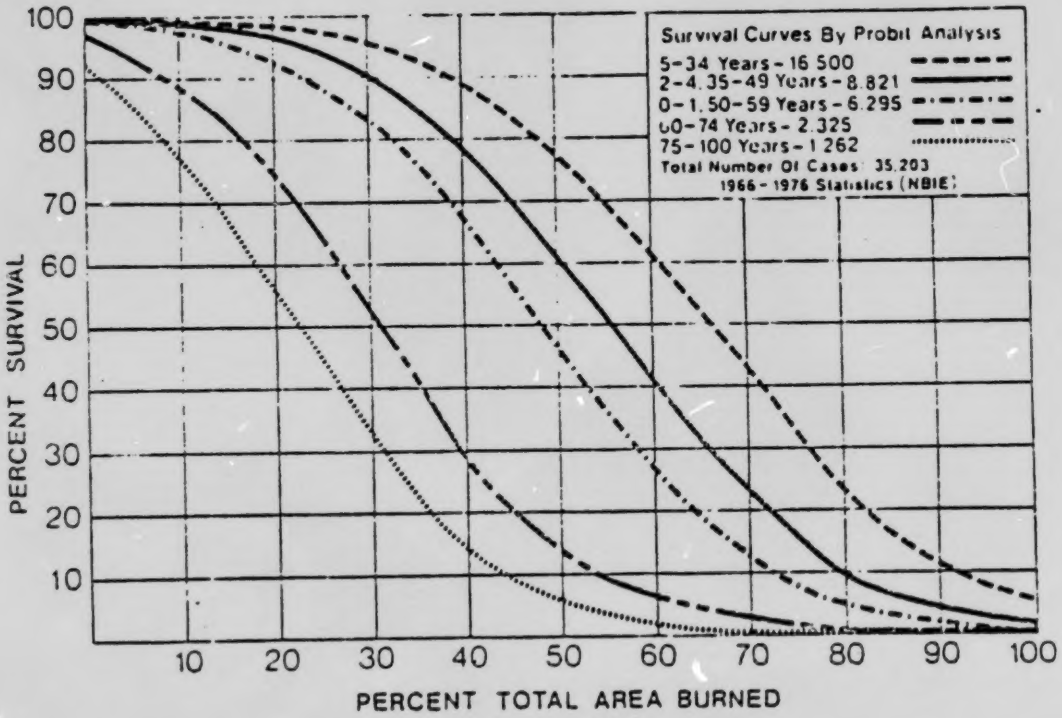

Figure 4. Survival rates of burned patients in different age groups, by percentage of total body area burned. (Source: Praiss, Feller & James, 1980:205)

investigated circumstances of 809 private home fires systematically selected from fire department records for two years. Interviews were conducted with members of fire households, their next door neighbors, and others designated as census tract controls.

Burns are a serious problem at any age, but in the elderly, the ratio of injury to death is least favorable. That is, old people are least likely to survive burns.

Table 13. Deaths from burns, by age groups for the U.S., 1977

	Number	Rate Per 100,000
All ages	6,357	3
Under 1	159	5
1-4	608	5
5-14	550	1
15-24	______	______
25-44	1,081	2
45-64	1,481	4
65-74	843	6
Over 74	1,023	11

Source: National Safety Council Accident Facts, 1980 Editor, p 8. These figures underestimate the importance of mortality from burns because they do not include inhalation, hot substance, corrusive liquid or steam or electrical burns.

Linn, reporting findings from the Florida study of 1,297 patients with recent burns, a judgmental sample of one third of the state's hospitals, including detailed information about treatment and recovery of elderly patients, (Linn, 1980: 120) showed that the elderly in that sample had more severe burns than people in any other age group. Those 65 and over had a higher body surface area burn mean than any other age group, and the percent of hospitalized patients with full thickness burns was much higher in the elderly group. In a much larger series than the Florida study, more than 35,000 hospitalized burn patients in the NBIE data set have contributed to "expected survival rates of patients of given age groups when admitted with a burn injury of specific magnitude and treated with the best medical resources available at the time and place." (Praiss, Feller, and James, 1980: 204-5) These curves, which are shown in Figure 4, show that a 35-49 year old person with 40% burns has about an 80% chance of survival, while the same amount of burn in a person 60-74 years old has a survival rate of 30%, and for persons over 74, the survival rate is approximately 6%.

The Florida data reported by Linn show that the elderly had more complications from their burn injuries and longer hospital stays. Long (1979) noted that elderly patients have great difficulty with infection after burns, apparently more than younger persons with the same major burn injuries. There are no epidemiologic data on the consequences of burns for those elderly persons who survive burns, but knowledge of the physical and psychological trauma of burn rehabilitation for even the most resiliant age groups is common knowledge.

The most frequent types of thermal injury resulting in hospitalization of the elderly are scalds, those caused by flames, and contact burns. In the New York study residential fires or conflagrations caused more than 70% of the burn deaths in upstate New York for the three year period including the hospital based incidence study (Feck and Baptiste, 1979: 316), but less than 4% of hospital admissions for burn injury were due to conflagration. Obviously many people die from residential fires before they get to the hospital. For the United States as a whole, death rates for burns for males over 65 are 3 times as high for non-white persons of both sexes. (UCD Statistics, U.S. 1975) Since in the New York Burn study elderly white females had nearly twice the conflagration injury rate as elderly white males (the injuries from conflagration for blacks were almost non-existent), one might conclude that white females are most likely to escape death but not injury from residential fires. Scalds were responsible for 40% of the burn injuries that resulted in hospitalization in the New York Study (Baptiste and Feck, 1979: 315), and of those hot liquid burns, 196 of the 793 of known etiology were tap water burns. Fifty percent of those tap water burns occurred to the 7% of the population under 5 years of age, and 27% occurred in the 15% of the population age 60 and older. Of the 188 tap water scalds with known place of injury, 95% occurred in the home. "Among the adults, the tap water burns often involved falling or losing consciousness in a bath or shower." (Baptiste and Feck, 1980: 728) In a California burn center study of 1564 children and adults, scalds were the most common cause of burn injury in both groups. (Jay *et al.*, 1977) The 15% of the hospitalized population 60 years and older had 22% of the burn injuries involving clothing. (Feck, Baptiste and Tate, 1978) Beverly (1976:106) reports similar findings in data compiled by the U.S. Consumer Product Safety Commission and through 1974. In addition, that study showed that matches, cigarettes, cigars, lighters, etc. were the most common source of fabric ignition for the elderly (accounting for almost 50% of the injuries) and kitchen ranges ranked second (accounting for 23% of fabric ignition injuries in the elderly). Sleepwear was implicated in 33% of the fabric ignition injuries. Waller (1980a:1573), citing the Pittsburgh Burn Study, states that "no matter what measure of severity is used whether fatalities, number of days hospitalized, or amount of third degree burns-fires that involve clothing are far more serious than those that do not. Of particular danger is heavy clothing that adds heat against the skin as it burns."

Developmental and other human factors; environments

Old people are not all alike, and to attempt one explanation of their somewhat greater susceptibility to thermal injury and their marked excess in mortality from burns is overly simple. Physical, social, and psychological features of normal aging; disease; and possibly biases against old people might help explain data on burns presented above. Disease and pharmacologic management of disease may impair perception, limit judgement, and restrict mobility. Medications prescribed for elderly people for more than one condition, by more than one clinician increases the risk of drug reactions; there are differences in absorption, distribution, metabolism and excretion and receptor site activity. (Krupka & Vener, 1979) While not all old people are ill, 2/3 report one or more chronic condition, and all experience some decrement in vision, hearing, smell, reaction time and physical strength. Linn (1980: 122) presents information that thinning of the skin due to decline in epidermal cell proliferation and changes in the dermis might account for a more severe burn resulting from the same amount of external heat as well as for poor healing. Even active healthy old people spend more time in their homes (where most burns to those over 65 occur), and many older citizens, especially women, live alone. Old people may fall against hot surfaces, have difficulty holding things without spilling, and have lesser sensitivity of nerve endings to hot substances. In addition an elderly person who is exposed to fire or hot water may not be able to remove himself until extensive trauma has occurred. Finally, preexisting cardiovascular, respiratory or renal disease limit the recuperative powers of the elderly. Is there bias in treatment of elderly injury victims? As noted earlier, in a study of non-highway injury emergency care, Waller reported that people under the age of 30 preferentially received assistance by lay people and professionals (Waller, 1973). Linn (1980) showed with data from the Florida Burn Study that even though the elderly had more severe burns, there were almost no differences in the treatments received in any of the adult age groups, even when data on subjects who died was removed.

Countermeasures

Baker and Dietz (1979:806) contend that even though "the etiology of burns is well understood, preventive efforts do not match our knowledge." Thus far preventive efforts have been intuitive, have been aimed at changing individuals, have placed excessive reliance on education, and have tended to blame victims of injuries. Feck, Baptiste and Tate (1979) have shown how to systematically apply countermeasure strategies to all phases of the burn injury problem (See Appendix). Barry (1975) has urged health professionals to seek abatement stategies which potentially affect entire communities and not just high risk groups. Baker (1975:101) notes that we will always need effective safety education, but we need a balanced mixture of approaches. No one would argue with "teaching" people not to smoke in bed, but we could add to that an array of strategies including support for redesign of matches for easier handling by impaired elderly, legislation requiring self extinguishing matches (Baker, 1980), more aggressive efforts in the area of flammability, etc. Finding an appropriate balance between respect for independence of frail or impaired elderly and safety surveillance is a challenging issue for health professionals, family members, and the elderly themselves.

We wish to highlight here one opportunity to prevent injury from hot tap water. Applying rates from the New York Burn Study to the U.S. population, (Baptiste & Feck, 1980:728) we estimate that 1,120 persons 60 years or older are treated as inpatients for tap water burns in this country every year. Feldman, et al. (1978) measured bathtub hot water temperature in a Seattle survey. They found that 80% of the homes visited had bathtub water temperatures greater than 130°F (54°C). At that temperature adult occupants (not elderly) are at risk of full thickness scald burns in 30 seconds. (Moritz, 1947; and Moncrieff, 1979: 24-25). The plumbing industry and the Consumer Product Safety Commission have proposed a voluntary standard requiring devices that limit the temperature to 120°F (49°C) (10 minutes for full thickness burn of adult skin). To achieve protection in existing plumbing fixtures hot water heaters would have to be set back or have anti-scald devices or mixing valves installed. Feldman et al. (1978:6) report that, "currently gas water heaters are preset at 60°C (140°F) (six seconds for a full-thickness scald of adult skin) and electric heaters at 66°C (150°F (two seconds for a full-thickness scald)." Baptiste and Feck (1980:728) cite evidence that "four of six major dishwashing detergents tested performed with good to excellent cleaning results and met public health germ kill standards at operating temperatures as low as 100°F." The Joint Commission on Accreditation of Hospitals permits a maximum allowable setting of 110°F for patient shower, bathing, and handwashing facilities. (JCAH: Accreditation Manual for Hospitals, 1980 Edition, p44). Substantial energy savings occur at lower hot water heater temperatures. No additional research or technological development is needed to eliminate this source of suffering for thousands of preschool children and elderly citizens. In private residences and longterm care facilities we can prevent tap water scalds.

Additional Research

More research is needed on fabric flammability, a complicated matter partly because of the potential for smoke and toxic gases from partially ignited treated fabric. (Beverly; 1976:109)

CONCLUSION

Injury is a nonrandom event of considerable consequence to older people. They have high death rates and high dysfunction and disability rates from falls, fires and contact with hot substances, and vehicular crashes to pedestrians and occupants of motor vehicles. Although deaths from falls have declined in recent years among the elderly, and deaths from motor vehicle crashes and thermal injury have not increased, all these injury events are important to reduce needless dependence and death and to improve quality of life for our elder citizens. Acceptable epidemiologic data describing nonfatal injury events is scarce. Better reporting of injury events may help us convince the public and professionals of the importance of the injury problem. But we already know enough to insist on effective injury prevention strategies. Health professionals in particular should have opportunities to learn about current approaches to injury control Logically following that would be greater care in prescribing drugs for the elderly, aggressive efforts foward improved emergency medical systems, and systematic efforts to reduce hazards in the environment.

FOOTNOTES

1. Portions of this paper were presented in March, 1977 at The Second Conference on the Epidemiology of Aging, proceedings published in 1980 (Hogue, 1980) and portions were presented at a symposium on Mortality Trends Among the Elderly, November 21, 1977, 30th Annual Meeting of the Gerontological Society, San Francisco.

2. Throughout this paper, unless otherwise noted, mortality data for 1975 are from the Underlying Cause of Death Statistics, United States, 1975, 100% sample. Unintentional injury includes in this analysis, W.H.O. International Classification of Diseases, External Causes E 810-E 949; E 980-E989. 1969 UCD, 100% sample. The assistance of George C. Myers (Director) and Kenneth G. Manton (Assistant Director), Center for Demographic Studies is gratefully acknowledged.

3. Crossover effect refers to the observation that prior to age 75, non-white males have the highest death rates. At age 75, white males "crossover" to have higher death rates.

4. For much more detailed presentations of interventions to prevent injury and death from motor vehicle crashes, see Baker and Dietz (1979:801-804); Waller (1980 a: 1561-1564); Robertson (1980); and Haddon (1979:51-63).

5. Studies which include readmissions for burn injury (Clark and Lerner, 1978) report a hospital admission rate of 33.

6. Another relevant regional study not reviewed for this report is the 1975 Pittsburgh Burn Study by J.I. Barancik and M.S. Shapiro, available as Report No. PB250-737 from the National Technical Information Service, Springfield, Va.

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APPENDIX

A Systematic Method for Identifying Burn Injury Prevention Options: Three Illustrations (Feck, Baptiste & Tate; 1979:134)

	Scalds, Infants, Household Tap Water	Flame Burns, ignition source Matches	Internal Chemical Burns in Children
1. Prevent the marshalling of the energy in the first place.	?	Replace matches with lighters, possibly electric?	Invent non-caustic substitutes for dangerous household chemicals.
2. Reduce the amount of the energy marshalled.	Lower the operating temperature of household hot water supply systems.	Fewer matches per book.	Smaller package sizes.
3. Prevent the inadvertent release of the energy.	Childproof faucets.	Matches of larger size for easier grip.	Childproof caps.
4. Modify the rate of release of the energy.	'Slow' faucets.	Lower burning temperatures.	Smaller diameter pour spouts.
5. Separate the host from the agent in space or time.	Parental supervision.	Matches of 6-inch length?	Lock chemicals away.
6. Interpose a physical barrier between agent and host.	Gates at bathroom and kitchen,	Lock matches away from children.	Childproof caps.
7. Modify the hazardous agent.	Automatic temperature-regulating water mixer valves.	Self-extinguishing matches.	Invent non-caustic substitutes.
8. Strengthen the structure susceptible to damage.	?	Flame retardant fabrics, flame retardant building materials.	?
9. Counter the continuation or extension of damage once begun.	Cool the wound.	Drop and roll. Cool the wound.	Antidote.
10. Maximize salvage after energy damage has occurred.	Specialized hospital facilities..	Emergency medical services, hospital facilities, rehabilitation services.	Poison control centers, emergency medical services, hosptial facilities.

EPIDEMIOLOGY OF SENILE DEMENTIA--FACT AND FRUSTRATION

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The good thing about being a bull, if we are to accept current dogma, is that if a red flag is waved in front of him he will know exactly what to do and in which direction to do it. The reasons for his act and its consequences are less clear, but considering the range of options it might be nicer to be a bull than an epidemiologist studying senile dementia.

Swerving from any hint of fact my first question is, did I use the correct terminology or should I be saying Alzheimer's disease? I shall be discussing the conditions associated with neuropathologic changes described in Alzheimer's disease, which includes both senile and presenile manifestations. Of greatest interest are the senile forms and perhaps for convenience and in my case from some sense of conviction, (see below) I will keep the senile forms and presenile forms separate. Since much more is known about the senile forms the bulk of the discussion will relate to those entities generally embraced by the term senile dementia Alzheimer's type (SDAT). Some overlap will be obvious.

Having solved nothing semantically, I will proceed to the unavoidable issue of whether SDAT is a disease or one of the forms of normal aging. Again, I will dodge the issue by saying it is convenient and potentially useful to consider SDAT a disease since, even if it is not a disease (and we surely will not be able to define "disease") it certainly involves a specialized pattern of degeneration. Thus although it shares aspects with normal aging there must be factors which cause it to appear and be recognizable in some people and not in others. Perhaps by analogy many people have high serum uric acid levels and altered purine metabolism patterns, but not all of these have gout.

The issue of Alzheimer's disease being one entity with a presenile form and a senile form cannot be resolved. There are those who logically argue that the early form and the late form involve the same disease both clinically and pathologically, but at different ages, and thus should be considered one entity. Others including myself would consider it premature to combine the two entities since rigorous data do not exist which would suggest that the pathogenesis and natural history of the early is indeed identical with that of the senile form. Since it's a pleasant game to argue a point by using another disease analogy, I would suggest that poliomyelitis and amyotrophic lateral sclerosis share about as much in common as the presenile and senile forms of Alzheimer's disease.

Further, etiologic research is better served if we consider the entities as separate. If one is caused by factor X and the other is not, we could miss the critical association by case dilution; while if both are caused by factor X it will be manifest in both groups so nothing is lost. A critical gap in our data is the age-specific incidence of the presenile and senile forms. If the distribution is biomodal with an early peak then a trough and then a steady rise, and if there are different clinical or epidemiologic patterns in the earlier and later forms it would suggest that separate etiologies are involved. I stress this point now because I believe a study to determine age-specific incidence can only be accomplished where the population is large, stable, and has access to good medical and diagnostic facilities. Israel certainly offers such an opportunity. The presenile form is rare but the ability to detect rare diseases within Israel has been demonstrated in numerous studies, particularly of neurologic diseases.

Epidemiology

The epidemiologist does not need a fixed and final diagnosis in order to ply his trade. Therefore, the decision as to whether SDAT is a clinical or pathological diagnosis is not, within the present state of knowledge, a critical issue as long as there is close general agreement between these approaches. The more germane problem is suggested by a quotation from Roth, "The most significant challenge of all is that presented by the contrast between ordinary senescence and Alzheimer's and other forms of dementia." (1) How do we treat this entity that Kral (2) poetically refers to as benign senescent forgetfulness? Perhaps the epidemiologist will be able to determine if this entity is simply normal aging or does indeed comprise a part of the natural history of SDAT.

General wisdom surges to the forefront, and in almost all series regardless of the criteria used, we find that among those who are clinically diagnosed as having a senile dementia from 50 to 65 percent will have SDAT. Malignant and nonmalignant forms are recognized, and rates throughout the world do not vary greatly; thus approximately 4 percent of the population over 65 years of age has what would be called the malignant form of senile dementia, and about 20 percent has what is clinically referred to as mild forms. The rates rise sharply with age approaching about 20 percent for severe forms at age 80.

This general conformity of data derived from population surveys, and to some extent from regional institutional surveys, suggests that diagnosticians are probably discussing the same entities and that with acceptable errors in the neighborhood of 100 percent this range of prevalence will probably be confirmed in more rigorous investigations (3-general reference).

Let me not belittle the complications in developing more rigorous studies. Cross-sectional surveys will always suffer the risk of misdiagnosis and overdiagnosis because of conditions which simply cannot be clinically separated during a single exam or even during a single exam with an appropriate followup. The problem is perhaps best exemplified by data from the Duke Longitudinal Study (4). In this investigation where strict criteria for diagnostic inclusion were established and utilized over time, it was estimated that 50 percent of the population who reach age 60 will have at least one episode of diagnosable brain impairment. Further, within the study, patients who were diagnosed as impaired at one time were normal when seen at another time. This slipping in and out of the demented state is clearly a subject that must be dissected through natural history studies. Unless we can establish which portion of the disease is progressive, at least in an overall, if not day to day framework, we will have the greatest of difficulties in aligning the conditions with organic deficits.

Now that I have registered some discomfort and yet some pleasure in the soundness and general reproducibility of the basic prevalence data, I am left with the yearning to be a bull with a red flag. Given we know something of prevalence, there is no comfortable epidemiologic pattern to pursue. In fact, SDAT is perhaps the only disease that comes to mind in which there is not a suggestion of an acceptable pattern which would aid epidemiologic thinking.

SDAT does concentrate in the elderly. Unanswered questions involve the age-specific rates from the presenile dementias through the oldest age groups. It is probable that SDAT rates continue to increase with age.

Many neurologic diseases begin later in life but then diminish. This is certainly true of amyotrophic lateral sclerosis and multiple sclerosis. Even Parkinson's disease seems to decline after the 80th or 85th year (5). Some pathologic observations among very old people (6) suggest a decrease in the presence of Alzheimer's associated neuropathologic changes. Autopsy studies in very old people are, of course, subject to considerable bias since a person with a diagnostic problem is so much more likely to come to autopsy than someone with general senile mental changes.

Clinicians tend to agree that there is a female excess in SDAT. EEG findings over time, however, suggest that fast wave activity is better preserved in females than in males (7). The likelihood that clinicians see more female patients is very great since females far outnumber males in the older and more susceptible age groups. Further, elderly females are much more likely to be widowed and living alone than elderly males, and hence would require institutionalization in the absence of social supports. It is unlikely from the information available that a true sex difference has been documented, although one may exist.

Among the Chamorro people of Guam and the other islands of the Mariana group there is a focus of dementia resembling presenile Alzheimer's disease associated with extrapyramidal features (8-review article).

To the best of my knowledge, there is no other known focus or geographic localization by country, latitude, urban-rural status, etc. No one would suggest that this topic has been addressed systematically but wherever people are old and studied, senile dementia has been reported.

What has been said for geographic distribution can also be said for race. No patterns have been detected. In the United States this is surprising since between 1950 and 1965 some patterns should have emerged since in many areas a high proportion of SDAT patients were placed in mental institutions. The issue may not have received full attention but if one considers that white females had a threefold greater chance of surviving to be 70 years of age then black males of the same birth cohort, we have an interesting epidemiologic problem. If the rates of SDAT are the same in black males and white females it would suggest that events which occurred before age 70 had little if any influence on subsequent development of SDAT.

There is no suggestion in the literature concerning clusters of cases with common exposures or occupations. One exception to this is perhaps among prize fighters who develop a syndrome which shares much in common with Alzheimer's disease. Thus trauma (at least that of the severity to which prize fighters are exposed) joins Guam in providing a deviation from the absolute random pattern of observed dementia.

Past medical history and psychiatric history have not been reported to influence the likelihood of developing SDAT. There are some reports of an association of SDAT with lower social status. Since diagnosis is dependent on the population examined, it is likely that those with fewer social supports would be more heavily represented in institutions. Further, most test batteries would tend to discriminate against people with less education. Again, this is not to claim that socioeconomic variables are not related to SDAT but to emphasize that convincing evidence of a casual association is lacking.

There are no data to suggest that trends exist or that rates have changed over time. Descriptions compatible with the clinical features of SDAT exist in literature and medicine from earliest writings. Obviously, with the increasing number of people surviving to later ages the absolute number of cases is increasing rapidly.

What can be sadder than an epidemiologist with a disease without a pattern. I must take heart from David Hume's discussion of miracles in his essay, "Concerning Human Understanding." "That no testimony is sufficient to establish a miracle, unless the testimony be of such a kind, that its falsehood would be more miraculous, than the fact, which it endeavors to establish." It is clearly more miraculous that there be no pattern than that the evidence thus far accumulated suggesting the absence of a pattern is incomplete and incorrect.

Pathology and Neurochemistry

Epidemiologists look to these brave fields for facts and facts are what we have. It remains to be determined, however, which if any of these facts is causally sufficient or necessary for SDAT. There exists a cluster of changes which are associated with normal aging but characterize the predominant findings in Alzheimer's disease. These include the neurofibrillary tangles in the form of paired helical filaments, senile plaques, granulovacuolar bodies, and Hirano bodies. In addition, congophilic angiopathy is frequently observed and there is increasing evidence of loss of the dendritic arbor. There are considerable data about the patterns of these findings and their intensity. All the world appears to be becoming increasingly reverential about the role of these lesions in the hippocampus.

Choline acetyltransferase (CAT) is similarly depressed with age but more markedly so with SDAT. We are gradually learning about enzymes which normally increase or decrease with age and frequently those which decline are observed at still lower levels among patients with SDAT. This appears to be true for norepinephrine and dopamine. Most attention, however, seems to be focused on the functioning of the cholinergic system.

It has been postulated that a combination of the neuropathologic alterations described above somehow reaches a threshold beyond which clinical SDAT proceeds. A similar argument could be made for CAT. In the many studies of brains of individuals dying with a diagnosis of senile dementia, approximately 50 percent have the above mentioned neuropathologic changes. About 20 percent do not have these changes but have severe atherosclerosis. The significance of this group remains unclear since SDAT is not a vascular disease. In another 15 percent or so both Alzheimer's like changes and atherosclerotic changes occur, and in approximately 10 percent there are other specific causes for the demented state. In a final 5 to 10 percent no distinctive pathology is encountered. Contrariwise in at least 10 percent of the elderly population without mental illness the changes usually ascribed to Alzheimer's disease occur at a sufficient frequency to overlap with the degree normally encountered in SDAT. Thus people without senile dementia can have the neuropathologic changes associated with Alzheimer's disease and patients with senile dementia can have normal brains histologically. This implies that we are surely not there yet in terms of being able to associate pathologic lesions with symptoms.

Attempts have been made to correlate the degree of dementia prior to death with the concentration of neurofibrillary tangles and senile plaques. There does appear to be evidence that both are correlated in a loose way. Although it has not been reported, to my knowledge, among non-Guamanian patients with dementia, Hirano et al.(9) did find that neurofibrillary tangles diminished with progression of disease. It is not clear whether senile plaques could similarly diminish with age and severity.

This observation makes a close correlation between clinical and neuropathological findings an elusive undertaking. Part of the problem involves deciding whether cell loss occurs among SDAT patients to a greater degree than among control patients of the same age. This is currently a matter of dispute (10). If cell loss occurs then it too would be one of the critical neuropathologic findings. At present, however, it is only the appearance of abnormal cells and particles that we are discussing. It is doubtful that all areas (hippocampus?) have been adequately surveyed to make a definitive statement concerning numbers of cells or concentrations of cells with lesions.

I wish to further emphasize that while Alzheimer's like structural changes are notable, the chemical abnormalities deserve considerable attention. Support for the logic of the importance of a chemical lesion is the study referred to above (4) in which the clinical course is not steadily progressive, but involves remissions and exacerbations. Further it is commonly observed that patients are clinically better at certain times of the day and for rather surprising periods, while following minor illness or perhaps a geographic move they degenerate suddenly. These rapid swings are more likely to be chemically than anatomically mediated since only the dead cells of Lazarus can rise again. We should recall that in Parkinson's disease, patients who had been practically immobile for years were able to move normally for a short period of time following intense emotional stimulation. Part of the chemical lesion in Parkinson's disease is now understood and amenable to treatment with L-dopa. There is rampant optimism in some quarters that an analogy exists with SDAT and the cholinergic system and that clinical improvement may result from flooding the nervous system with choline or choline precursors (lecithin).

The rapid advances in neuropathologic techniques and neurochemical techniques seem to be ushering in an exciting phase in the understanding of SDAT. Many questions remain and are being actively pursued.

The Correlational Scramble

In recent years an array of excellent scientists has been studying aspects of SDAT and tantalize us with a wide range of observations. As of this writing I am reminded of the quote by Mechanic on medical sociology (11). "The field of medical sociology, thus, is not a single fabric to be woven together, but rather a series of threads going in many directions at once." I shall briefly refer to some of the recent directions in SDAT investigations.

Aluminum studies in cats, tissue culture, and neurons containing neurofibrillary tangles seem to offer a lead. Most data tend to confirm a higher affinity for aluminum in specific tissues in SDAT (12). The significance is far from clear since the people at greatest exposure to aluminum, such as aluminum workers and individuals on renal dialysis, do not necessarily develop neurofibrillary tangles or SDAT. Perhaps, however, aluminum is an indicator of some metabolic process involving the parathyroid and metallic ions which is either causally or passively associated with SDAT.

Genetic influences have been prominent in thinking about presenile and senile forms of Alzheimer's disease (3). Most of the early clinical studies gave varied patterns compatible with no genetic influence; a relationship with presenile dementia and SDAT in the same families; a relationship between SDAT with presenile dementia in the same families; and mathematical models which could be interpreted as autosomal dominant inheritance with incomplete penetrance or with age-dependent penetrance implying that if the person lived long enough eventually penetrance would be complete. The possibility of polygenic factors has also been discussed. Data necessary to sustain autosomal dominant inheritance with incomplete penetrance or polygenic modes of inheritance are virtually impossible to obtain and certainly unavailable at present. In the Guam form of dementia which occurs at an extraordinarily high rate, no Mendelian pattern of inheritance has emerged. There is a well documented, very rare form of familial Alzheimer's disease in which many of the cases have onset in the presenile age range.

Recent studies of autopsied patients with Alzheimer's disease of presenile and senile forms encountered elevated frequency of Down's syndrome in family members as compared with the normally expected rate for Down's syndrome. My information at present suggests that this association is much stronger when the Alzheimer's disease appeared in its presenile form (13). Several groups are studying patients with Down's syndrome to detect if the observation can be sustained starting with this illness and encountering an unusually high frequency of Alzheimer's disease. Studies are also under way to detect if Alzheimer's disease occurs more frequently in the offspring of elderly parents. The suggestion is that Alzheimer's disease could be late onset Down's syndrome. The chromosomal dislocations encountered in Down's syndrome are not seen in Alzheimer's disease, but fuel to ignite the imaginations necessary to conduct these studies is provided by the fact that in Down's syndrome, the great majority of patients who survive into adulthood develop neurofibrillary tangles which are indistinguishable from those in Alzheimer's disease. Chromosomal studies among familial and nonfamilial Alzheimer's disease (presenile and senile forms) have given inconsistent results. The most persistent finding is of aneuploidy in Alzheimer's disease (14). Aneuploidy is, of course, a difficult finding to interpret particularly if results are not consistent from patient to patient and laboratory to laboratory. In making chromosome preparations for study, perhaps the most common artifact is apparent aneuploidy resulting from the loss of a part of a chromosome during the extensive manipulation.

Histocompatibility typing has been conducted. Recently data were summarized from approximately 60 patients including nearly equal numbers of SDAT and the presenile form of Alzheimer's disease. There were no differences between the two age groups. HLA type B7 was significantly increased in all Alzheimer's disease. Previous reports of positive associations with other HLA types were not sustained. Workers in the field have the impression that something is definitely going on. There is a provocative increase in homozygosity of HLA types with age. Most intriguing is a suggestion of a B7-CW3 haplotype being greatly increased among Alzheimer's patients of all ages when compared to the general population (15). More will surely be heard concerning HLA typing and senile dementia. It is worth noting that the types that appear to be associated with Alzheimer's disease are not found in Down's syndrome.

The possibility that SDAT is caused by a slow virus cannot be dismissed. Studies among Guamanians with dementia were coupled with the original kuru studies in the first primate experiments. Thus far the Guam material has been entirely negative using the same techniques which did transmit kuru and several human slow virus diseases of the central nervous system (CNS). In the late 1960's material from several unusual patients with familial Alzheimer's disease produced a spongiform degeneration in chimpanzees indistinguishable from the neuropathology encountered with inoculations of kuru brains. Numerous attempts to reproduce these transmissions from the original material and from many other patients with familial and nonfamilial dementias of the presenile and senile form have been entirely negative to date (16). The early observations, thus, are essentially uncorroborated by the scientists who performed the work and at present virus studies must be considered negative.

There are numerous suggestions of immunopathology among SDAT patients. There have been reports of brain specific antibody and of immunoglobulins being identified in senile plaques. Attempts to correlate immunoglobulin levels with disease or test performances have on occasion given positive or suggestive results. Eisdorfer sums up the data nicely (17). "In the aggregate, there appears to be a nagging relationship between components of the immunoglobulin system and certain aspects of cognitive performance." Yet another provocative observation is an association of Alzheimer's disease both presenile and senile with haptoglobin gene Hp^1. This gene is also reported to be associated with an excess risk of leukemia and a less efficient general immune responsiveness. In Down's syndrome there is also the suggestion of diminished immune responsiveness and an excess of leukemia. Haptoglobin type distribution in Down's syndrome, however, is apparently normal (18).

The Epidemiological Gulf and the Categorical Imperative

Kant will hopefully forgive me for mangling his logic and solutions for my purposes. It is time to take the leap across the epidemiological gulf. The categorical imperative employs a methodology which should work if we are dealing with a disease or a series of discreet entities. This then is the primary supposition. The impediments to direct acquisition of information are all too clear through the numerous examples of positive and less than positive data and suggestions strewn through the prior portion of this manuscript. We are notably crippled by lack of useful definitions. I do not think we will solve this problem, and so will have to determine functional definitions which are testable in populations. A primary need is for a series of viable, clinical, and psychometric instruments. These must include instruments which can be used for field testing, others which can be used in hospitals and clinical settings, and others which are useful for following patients over time. Until we can find scales with high degrees of correlation with outcomes we will make little progress. There is need for a rough rating score such as that which is referred to as the Kurtzke Scale for multiple sclerosis which quantifies severity of a range of clinical signs and symptoms.

I suggest that these efforts go on in many populations with many different instruments and types of patients. Of course, communication between investigators is necessary, but the most important thing is for enough people to keep working until epidemiologic patterns begin to emerge which will suggest the etiology, or at least the direction, which laboratory studies should take.

Perhaps during this challenging and lengthy evolutionary phase a pathologist or immunologist or chemist will get lucky and shortcut all our efforts. This, of course, would be fine news indeed. Epidemiologic and laboratory studies of multiple sclerosis present what is perhaps an instructive and useful model for investigation of CNS disease. Having worked both at the bench and in the field, I think at present that more firm insights exist through epidemiologic studies than through laboratory investigations. Both epidemiologically and in the laboratory, some of the most sophisticated thinking in neurology has occurred in the study of multiple sclerosis. This is becoming a bit embarrassing since, alas, that effort has produced no answers to a disease of far less magnitude than senile dementia with far more clues and many large laboratories and epidemiologic groups devoting full-time attention to the problem.

I do, however, profess to the prejudice that the hippocampus is harder to get to than a well studied series of populations. My own program is geared to the detection of patterns in populations and potential associations with the numerous laboratory suggestions. We are also doing some work on the possible relationship between Alzheimer's disease and Down's syndrome and the development of a Kurtzke-like scale for SDAT. Natural history of the disease or diseases also takes great prominence in our efforts. The categorical imperative is the hope that what we are doing is methodologically sound and credible. Pray for patterns!

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Estrogen Use and Postmenopausal Women:

A Basis for Informed Decisions

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Abstract

A panel of experts convened by the National Institute on Aging, National Institutes of Health, reached the following consensus regarding estrogen use and postmenopausal women. The use of estrogens alleviates vasomotor symptoms and atrophy of the vaginal epithelium and might aid in preventing osteoporosis. However, it increases the incidence of endometrial cancer. The addition of progestins might prevent this complication, but its potential risks have not been adequately evaluated. Convincing evidence that postmenopausal estrogen use influences the occurrence of cardiovascular disease and breast cancer does not currently exist. Many aspects of the menopause and its management reguire further research. Any candidate for postmenopausal estrogen use should be given as much information as possible about both benefits and risks and then, with her physician, reach an individualized decision regarding whether to receive estrogens.

The postmenopausal use of estrogens, a topic of considerable public health importance, presents a complex array of benefits, risks, and unknowns. In an attempt to reach the best conclusions and recommendations possible at present, the National Institute on Aging, National Institutes of Health, held a Consensus Development Conference entitled "Estrogen Use and Postmenopausal Women" on September 13 and 14, 1979. As an NIH consensus activity, it brought together practicing physicians, biomedical researchers, and members of the public.

Chaired by Kenneth J. Ryan, M.D., Chief of Staff, Boston Hospital for Women, the conference began with 3 background papers: "Indications for Estrogen Replacement Therapy" by Isaac Schiff, M.D., Boston Hospital for Women; "Effects of Exogenous Estrogen on Postmenopausal Women: The Epidemiologic Evidence" by Barbara S. Hulka, M.D., M.P.H., University of North Carolina; and "Estrogen Use in Postmenopausal Women: Costs, Risks, and Benefits" by Milton C. Weinstein, Ph.D., Harvard University. Discussion by the conference panel, consisting of nominees of 10 organizations with relevant fields of interest (Table I), and by the audience followed. The panelists and other invited participants then prepared and presented to the audience a preliminary statement of consensus, which summarized the current state of knowledge and concluded that the decision whether to use estrogens must be an individual, informed choice for each woman. Members of the audience expressed their support and provided suggestions, which were used in revising the document.

The report that follows summarizes the currently available information on postmenopausal estrogen use, as presented by the invited speakers, panelists, and members of the audience. Each section consists of an excerpt from the consensus statement, followed by commentary. The 3 background papers have been submitted for publication, and copies can be obtained from the NIA.

Relief of Vasomotor Flushes

> In approaching the topic, the group first reviewed the evidence for the efficacy of estrogens in treating specific conditions associated with the menopause. It was accepted that estrogens are more effective than placebo in decreasing the frequency and/or severity of vasomotor symptoms (hot flashes and sweating). The questions that remain to be answered include whether vasomotor symptoms represent a homogeneous entity with a single cause and why some patients require much larger doses than average to control symptoms. There was general agreement that the decision of whether to initiate therapy should depend on the severity of the symptoms and the patient's perceived need for relief and that the lowest effective dose should be utilized. The occurrence of hot flashes naturally declines over a period of time, and unnecessary prolongation of therapy should be avoided.

Vasomotor flushes ("hot flashes" or "hot flushes") and sweats affect many, but not all, women. These poorly understood symptoms generally begin around the time of menopause, continue for varying periods of time thereafter, and eventually subside spontaneously. The amounts of discomfort and interference with daily life vary considerably among individuals and cultures. Although some physicians have stated that these symptoms may predispose women to respiratory infection or precipitate bronchospasm in asthmatics, vasomotor flushes are not generally thought to be harmful, and thus treatment is not considered necessary for maintenance of physical health.

Research[1] confirms the popular impression that estrogens alleviate vasomotor flushes but indicates that a placebo effect, although smaller, also exists. For unknown reasons, the dose of estrogen needed to control these symptoms varies greatly among women and can be relatively high. Vasomotor flushes tend to recur when estrogen use is discontinued. Because the risk of adverse effects increases with duration and possibly also dose, therapy should consist of the lowest effective dose for the shortest possible period of time.

Topics for further investigation include the epidemiology and mechanism(s) of hot flashes, as well as the items cited in the consensus statement.

Treatment of Genitourinary Changes

It is recognized that estrogens are effective in overcoming the atrophy of the vaginal epithelium (wall) and the associated symptoms, which may include dryness, burning, itching, and pain on intercourse. It was suggested that the possible relationship of urinary tract symptoms to estrogen lack be more thoroughly investigated. Attempts to avoid systemic effects by treating vaginal symptoms with local application of estrogen-containing creams have been common. However, evidence now exists that the estrogens in these creams may be absorbed rapidly into the bloodstream. The biological consequences of this absorption are undetermined and require study.

Following the menopause, atrophy of the vaginal epithelium can produce the symptoms noted above. Relief of these complaints generally occurs during estrogen use[2] and can persist for varying lengths of time afterward. Estrogens do not, however, appear to be effective in treating vaginal relaxation.[3]

Postmenopausal women sometimes experience dysuria and urinary frequency in the absence of positive urine cultures. These symptoms might result from estrogen deficiency, as the vagina and the urethra possess a common embryonic origin. This hypothesis and the possible role of estrogens in treating urinary tract symptoms deserve investigation.

At one time thought to have only local effects, intravaginally applied estrogens have been prescribed to women in whom systemic estrogens are contraindicated. However, estrogens administered by this route appear to enter the bloodstream rapidly and escape initial metabolism by the liver.[4] Furthermore, the possibility of local effects on the endometrium is of concern. Intravaginal estrogen administration requires further research before recommendations can be made about its use.

Psychological and Cosmetic Effects

There is no evidence at present to justify the use of estrogens in treatment of primary psychological problems. Surveys have shown no established specific or temporal association of sleep patterns, mental performance, mood, or psychological state with menopause or estrogen deprivation. On the other hand, in preliminary intervention studies comparing estrogens to placebo, effects on sleep latency and REM sleep have been noted. Some improvement in mental well-being in women receiving estrogens may be secondary to alleviation of physical symptoms.

The psychological characteristics of the menopausal stage are incompletely defined, but this period of life does not, as once thought, appear to be characterized by a high incidence of new and distinctive mental illness. Nevertheless, the menopause is a psychological as well as physical milestone in the aging process. Such times of transition typically are stressful and require that appropriate support be available.

Although estrogens are not indicated in the treatment of primary psychological problems, the possibility exists that estrogens may have psychological benefits in some women. Studies of the emotional and cognitive effects of estrogen administration have differed in populations examined, variables considered, and methods used. Results of these studies also have varied, and thus no conclusion can be drawn regarding which, if any, psychological functions may be altered by estrogen administration. One study's finding that estrogen use produced more improvement of psychological state in women with severe hot flashes than in those with milder symptoms[5] suggests that an increased sense of emotional well-being may be secondary to alleviation of physical discomfort associated with the menopause.

Preliminary findings suggest that estrogen use may improve the quality of sleep. In a double-blind crossover study,[6] estrogen use was correlated with decreased sleep latency (a shorter time between lights out and sleep onset), more rapid eye movement (REM) sleep, and a greater percentage of time spent in REM sleep.

At one time, it was hoped that estrogens would retard the development of wrinkled skin, gray hair, sagging breasts, and other physical signs of aging. However, it now appears unlikely that they have any such cosmetic benefits.

The psychological characteristics of the menopause, as well as the effects of estrogens on emotional state, cognitive function, and sleep, deserve further research.

Effects on Bone

The group acknowledged the validity of three randomized trials indicating that exogenous estrogens can retard bone loss if given around the time of the menopause. Except for dietary calcium, which appears to decrease bone loss to a lesser extent, other substances have not been shown to have such an effect. It is inferred but not proven that this retardation of bone loss will prevent the ultimate development of osteoporosis and attendant fractures. Case-control studies not yet published but discussed at the meeting report an association of estrogen use with a decreased risk of osteoporosis-related fractures. However, more data are definitely needed before the efficacy of estrogens in preventing fractures can be established. An inconsistency was noted: namely, in the randomized trials, accelerated bone loss following discontinuation of estrogen use resulted in loss of any favorable effect on bone mass, whereas in the case-control studies, use of estrogens at any time in the past conferred some protection against fractures. Identification of patients at increased risk of osteoporosis would be desirable because of the strong possibility of successful prophylaxis. One high-risk group in which to investigate possible benefits of estrogens consists of patients who already have developed osteoporosis and sustained fractures. Estrogen administration represents a promising approach to prevention of the widespread problem of hip fracture.

Following the menopause, loss of bone mass, which begins previously, accelerates, and the incidence of fractures--especially those of the proximal femur (hip), vertebrae, and radius--increases markedly. An estimated 200,000 Americans, most of them older women, suffer hip fractures each year, at a probable cost of over $1 billion. Thus, measures to prevent, arrest, reduce, or reverse bone loss--and thus presumably decrease the risk of fractures--are of considerable clinical and public health importance.

Lack of estrogen hastens the loss of bone and thus the onset of osteoporosis. However, several other factors--including immobilization, white race (and, in particular, fair coloring), slenderness, heavy drinking, low calcium intake, and cigarette smoking--may also increase the risk of osteoporosis. Thus, even if generally effective, estrogen use may not always be sufficient to prevent fractures, and potential exists for decreasing the risk of osteoporosis by means other than estrogen administration.

Research[7,8,9] indicates that low doses of estrogens can arrest or retard bone loss if given for several years shortly after the menopause, but the effects of estrogen administration on bone mass over longer periods of time require study. Preliminary evidence, including a case-control study[10] that was in press at the time of the conference, suggests that estrogens do, as predicted, decrease the incidence of fractures.

Topics for further research include the effects of dose, duration, and recency of estrogen use on bone mass and on risk of fractures, as well as alternative ways to maintain the quantity and quality of bone.

Cardiovascular Effects

> There is no convincing evidence that estrogens in customary doses increase the risk of thromboembolic phenomena, stroke, or heart disease in women who have undergone natural menopuase. Although it was once hoped that estrogens would protect against heart disease in aging women, this effect has not yet been demonstrated. One promising approach would be to devise a more physiological mechanism for estrogen replacement. Because oral therapy results in the delivery of supraphysiological concentrations of estrogens to the liver, it can exert an exaggerated effect on lipoprotein metabolism, blood coagulation, and other important processes.

The cardiovascular effects of postmenopausal estrogen use remain incompletely defined.

Because the ratio of deaths from myocardial infarction among women to those among men increases sharply beginning between ages 55 and 65, it was initially inferred that the risk of cardiovascular disease suddenly increases after the menopause. However, more careful examination of the data shows that these death rates in women increase at a constant rate throughout life, and that the abrupt change in risk ratio reflects a decrease in the rate of increase in mortality for men. Thus, the epidemiologic support for the hypothesis that estrogens protect against cardiovascular disease is not as strong as once believed.

Because of this alleged protective effect, the Coronary Drug Project, designed to test the effectiveness of various drugs in preventing death and further illness in men aged 30 to 64 who had suffered one or more previous myocardial infarctions, included a study of the effects of estrogens. With an average of 18 months of follow up, the group receiving 5 mg of conjugated estrogens per day suffered an excess number of non-fatal myocardial infarctions, pulmonary emboli, and episodes of thrombophlebitis; a dose of 2.5 mg per day for the same period of time did not affect outcome.[11] Generalization of these findings to postmenopausal estrogen users--who are women rather than men, generally lack previous history of myocardial infarction, and normally receive doses of 0.625 or 1.25 mg per day--is not likely to be valid.

Several studies have examined the relationship of postmenopausal estrogen use to various cardiovascular disorders. In contrast to findings with oral contraceptives, case-control studies of two populations[12,13] show no association of myocardial infarction and exogenous estrogen administration. Two studies of a retirement community[14,15] found that estrogens were positively associated with hypertension, but, after controlling for blood pressure, not with stroke; but a third study of the same population[16] reported no such relationship. A review of cases of idiopathic venous thromboembolism[17] suggests that postmenopausal use of estrogens, unlike the use of oral contraceptives, does not increase the risk of this condition. Two follow-up studies[18,19] suggest that estrogen administration might decrease the incidence of and mortality from cardiovascular disease, but methodological problems limit the conclusions that can be drawn.

Postmenopausal estrogen use increases serum levels of high-density-lipoprotein cholesterol,[20] which are inversely related to risk of myocardial infarction, but does not restore a premenopausal lipid profile.[21] Non-oral routes of estrogen administration, which avoid delivery of supraphysiological doses to the liver, may exert more physiological effects.

Topics for further research include the effects of postmenopausal estrogen use on blood pressure, on serum lipid levels, and on risk of myocardial infarction, stroke, and thromboembolic phenomena; and the effects of estrogens administered by non-oral routes.

The Risk of Endometrial Cancer

The group then reviewed the evidence for adverse effects associated with postmenopausal estrogen use. In the absence of exogenous estrogens, the incidence rate of endometrial cancer is approximately 1 per 1,000 postmenopausal women per year. It was recognized that this rate increases several fold beginning after approximately 2 to 4 years of use of 0.625 or 1.25 mg of conjugated estrogens per day. Evidence was presented that the risk of endometrial cancer increases with the duration of use and declines after discontinuation. Estrogen use is most strongly associated with lesions of the lowest grade and earliest stage. Of interest is the temporal relationship of the number of estrogen prescriptions and the incidence of carcinoma of the endometrium: both rising steadily until 1976 and then declining in parallel. Although the incidence of carcinoma of the endometrium rose, mortality from the disease did not increase. A considerable part of this discrepancy may be attributable to early detection and the high cure rate.

Cystic hyperplasia of the endometrium, which is considered a premalignant condition, has been associated with unopposed estrogen, whether endogenous (as in anovulatory states) or exogenous. The cost effectiveness of sampling the endometrium in order to screen for endometrial hyperplasia and cancer in completely asymptomatic women currently or potentially receiving estrogens is uncertain at present. It was agreed that suction curettage is effective in evaluating the endometrium and that the cause of any bleeding must be determined. A report indicating that uterine bleeding may sometimes be absent early in the course of endometrial cancer was presented at the meeting. Hence, prudence would suggest that, even in the absence of bleeding, the endometrium should be sampled before and during estrogen therapy (on a yearly basis).

The use of progestins for several days of each estrogen treatment cycle has been demonstrated to decrease the occurrence of endometrial hyperplasia and might also reduce the associated risk of developing cancer of the endometrium. Before the application of combined therapy becomes established, risks of the various progestins must be adequately evaluated.

Endometrial cancer is the main recognized risk of postmenopausal estrogen use. As summarized in Table II, several case-control studies of different populations[22,27] support this association. Horwitz and Feinstein[28] have challenged the methodology and conclusions of such studies, but their objections do not appear to have been widely accepted. Of course, women who have undergone hysterectomy cannot develop endometrial cancer.

Risk increases with duration of estrogen use, but its relationship to dose remains uncertain. The temporal association of estrogen use and endometrial cancer suggests that estrogens may function as promotional agents rather than carcinogenic initiators.

In postmenopausal women taking estrogens, the administration of progestins for several days per cycle has been reported to reduce the prevalence of endometrial hyperplasia.[29] Thus, it has been suggested that the addition of these substances might decrease the risk of endometrial carcinoma in this population. However, the possible risks of administering progestins to postmenopausal women are largely unexplored.

Topics for further research include the relationship of estrogen dose to the risk of endometrial cancer, the favorable and unfavorable effects of the addition of progestins, and the yield and cost-effectiveness of screening potential and current estrogen users for endometrial hyperplasia and asymptomatic endometrial cancer.

The Possible Risk of Breast Cancer

The association of estrogens and breast cancer in experimental animals is well known. Careful review of several well-conducted case-control studies has not revealed such a relationship in humans. In two followup studies of estrogen users, varying associations were encountered. Compared to data on the general population, one showed an excess of cases in years 5 to 9, but the other only after 15 years, of estrogen use. Incidence rates of breast cancer have not changed in parallel with those of estrogen use, as have those of endometrial carcinoma. Because of the high incidence and relatively poor prognosis of breast cancer, any possible association with estrogen use remains a concern.

As summarized in Table III, multiple well-designed case-control studies[17,30-36] have shown no significant association between estrogen use and breast cancer. For several reasons, however, the possibility that estrogen use increases the risk of developing this condition deserves further attention. Estrogens can induce breast tumors in animals. In addition, the latency period in humans may be so long that an increase has not yet been detected. Furthermore, estrogen administration might produce breast cancer in some groups of women or might stimulate incipient tumors. Two practice-based follow-up studies have found some increased risk--one during the first 10 years of estrogen use,[37] the other after approximately 15 years thereof;[38] but methodological problems limit the inferences that can be drawn.

Additional research and surveillance are needed. Major studies of the possible relationship of postmenopausal estrogen use and breast cancer are now in progress.

Other Possible Risks

There are experimental data indicating that estrogens can induce the production of lithogenic bile, and in one study a 2.5-fold relative risk for the development of surgically confirmed gallbladder disease was observed.

The possible association of postmenopausal estrogen use and gall bladder disease[17] requires further investigation.

The effect, if any, of estrogen use on the risk of ovarian cancer has received relatively little research. However, one well-designed case-control study[39] showed no association between the two.

Estrogen Use After Premature Menopause

Some concern was expressed about women who have undergone menopause many years in advance of the normally expected age. Although most of the participants felt intuitively that approximation of the normal physiological state through hormone replacement therapy would be best, there are no carefully controlled studies comparing the risks and benefits in these circumstances. Support was voiced for conserving the ovaries of young women when possible.

Those women in whom surgical or other factors result in loss of ovarian function many years before the normal time of menopause present special considerations. Such individuals can experience vasomotor symptoms and can develop vaginal epithelial atrophy while relatively young. In addition, they lose bone prematurely and thus may be at risk of more and earlier fractures than usually observed. Furthermore, early loss of ovarian function may hasten the development of coronary vascular disease.[40,41] However, early castration also can decrease the risk of breast cancer. Oophorectomy often is accompanied by hysterectomy, which eliminates the possibility of developing endometrial cancer. More data are needed before a definitive statement can be made.

General Conclusions

One area of general agreement was that the patient should be given as much information as possible about the evidence for the effectiveness of estrogens in treating specific menopausal conditions and the risks that their use may entail. Patients must be kept continually informed of new findings as they arise. Given the current state of knowledge, no general recommendation, applicable to all postmenopausal women, can be made.

General consensus was reached on the current state of knowledge, as described. It is clear, however, that much additional information is needed. Specifically, we need systematic knowledge of the natural course of the menopause in the absence of hormonal therapy, of alternatives to estrogen use, of the optimal way to provide estrogens if they are to be used, and of all aspects of their beneficial and adverse effects. Special attention should be directed toward studies that can determine the proper use of estrogens in young women having undergone oophorectomy ten or more years before the natural time of menopause. No general formulation regarding therapy can be given. Rather, each individual patient must base her decision on the relative values that she assigns to relief of symptoms, to expectations for optimizing health and well-being, and to various risks sustained in the process. Socially and culturally based attitudes toward the menopause may influence these values and require further definition.

Alternatives to Estrogen Use: Considerable interest exists in the use of measures other than estrogens to prevent and manage specific menopausal and postmenopausal conditions. Among the non-estrogenic substances that have been found useful in controlling hot flashes are intramuscular[42] and oral[43] medroxyprogesterone acetate and clonidine.[44] In women with symptomatic vaginal epithelial atrophy, water-soluable lubricants can aid in preventing dyspareunia. An increased intake of calcium, the absorption of which becomes less efficient after the menopause, appears to retard bone loss[8,9] and thus might reduce the risk of fractures; other means of preventing osteoporosis have been proposed but not well tested.

Good nutrition and exercise have been popularly promoted for general well-being in the postmenopausal years. In addition, educating women about what to expect around and after the time of menopause may help them to cope effectively with various changes.

Types of Estrogens: Various estrogens bind to the same receptors and thus when administered in comparable doses have similar effects, both favorable and unfavorable. However, estrogens administered by different routes can undergo different patterns of metabolism and thus vary in their relative effects on specific organs.

The estrogen preparation that has been most widely prescribed in the United States is a mixture of conjugated estrogens that is obtained from the urine of pregnant mares and of which sodium estrone sulfate seems to be the component present in largest quantity. At present, the standard dose appears to be 0.625 mg per day. When administered orally, these estrogens pass through, affect, and are largely inactivated by the liver before entering the sytemic circulation. Thus, they tend to alter serum levels of compounds associated with the liver, such as sex hormone binding globulin and cortisol binding globulin, more than those of such substances as FSH and LH.

Estradiol is the predominant estrogen produced premenopausally and thus might be the most physiologic compound for replacement therapy. However, when taken orally, it is extensively metabolized and appears largely as estrone in the blood.[45] When placed in the vagina,[4] injected, or implanted, estradiol enters the bloodstream. Ethinyl estradiol and mestranol are stable when taken orally but might be hepatotoxic, as young women taking oral contraceptives containing these substances are at increased risk of hepatic adenomas.

Estriol was once hypothesized to be the safest form of estrogen. However, at doses high enough to provide the benefits of estrogen use, the risks are likely to be the same as those of other estrogens.

Question often arises regarding the relative compositions of estrogen preparations used postmenopausally and the "birth control pill." In general, postmenopausal women receive considerably lower doses of estrogens than are present in oral contraceptives. Furthermore, the latter contain both estrogens and progestins.

Contraindications to Postmenopausal Estrogen Use: Among the conditions commonly considered contraindications to the use of estrogens for the relief of menopausal symptoms are: previous cancer of the breast or endometrium; strong family history of breast cancer; and history of stroke, myocardial infarction, thromboembolic phenomena, and other cardiovascular conditions. In addition, women who have received diethelstilbestrol during pregnancy or while *in utero* have been advised not to receive exogenous estrogens.

Weighing the Benefits, Risks, Unknowns, and Costs: A woman's decision whether to use estrogens involves weighing the benefits, risks, and unknowns. In addition, the costs involved are of personal and social importance.

At the conference, Dr. Milton Weinstein approached this problem through cost-effectiveness analysis. Costs induced by the use of estrogens include not only that of the medication itself but also those amassed in the treatment of complications. However, estrogens might also reduce costs by preventing fractures. Likewise, estrogen use can increase mortality by causing endometrial cancer and necessitating surgery, but it also might reduce the number of deaths from hip fractures.

Because much remains unknown, the net effects on cost and life expectancy cannot be precisely determined. Furthermore, these values vary depending on the criteria used to select patients for treatment. Nevertheless, these effects appear to be small. Thus, based on the assumptions used, the costs induced and those saved by estrogen administration approximately counterbalance each other. Likewise, years of life lost and gained seem similar in number. These conclusions apply only to the general population of estrogen users, and any individual woman might incur a large net gain or loss in life expectancy or cost.

Quality of life is a major consideration. Estrogen use can enhance the quality of life by relieving menopausal symptoms and perhaps by preventing fractures, but it also can diminish it by producing complications such as endometrial cancer and by resulting in worry about possible adverse effects. Even if quality of life is assigned modest quantitative importance in Weinstein's model, it has a much greater effect than life expectancy on the cost-effectiveness--and, in personal terms, on the desirability--of treatment. This finding implies that the decision whether to use estrogens should be an individual one, based on the relative values that each woman attributes to relief of symptoms, possible long-term benefits, and potential risks.

Similarly, the conference participants agreed that no uniform recommendation, applicable to all women, can be made regarding whether estrogens should be used. Rather, they noted, the decision must be a personal one. To make this choice intelligently, women must be given as much information as possible about both the desirable and undesirable effects of estrogen use. In addition, women must be kept up to date as new findings become available. The development of more effective means of educating women about estrogens and aiding them in making satisfying decisions deserves attention.

The decision whether to use estrogens is not an isolated event. Rather, it occurs in the context of a woman's personal history and many other, as yet incompletely understood medical, psychological, social, and cultural factors relating to the menopause and aging. Thus, the woman and her physician should confer openly and arrive together at the total approach that, whether it includes estrogen use or not, is most likely to promote her general well-being during the postmenopausal years.

TABLE I:

PANELISTS AT CONSENSUS DEVELOPMENT CONFERENCE ON ESTROGEN USE AND POSTMENOPAUSAL WOMEN

Panelist	Nominating Organization
Elizabeth Barrett-Connor, M.D.	American College of Preventive Medicine
Daniel D. Federman, M.D.	American College of Physicians
Gerald A. Glowacki, M.D.	American Geriatrics Society
Saul B. Gusberg, M.D.	American Cancer Society, Inc.
Elizabeth D. Jones, M.S.W., C.S.W.	Women's Hormone Information Service
Weldon G. Kolb, M.D.	American Academy of Family Physicians
Howard L. Judd, M.D.	American College of Obstetricians & Gynecologists
Stanley G. Korenman, M.D.	Endocrine Society
Anne M. Seiden, M.D.	American Psychiatric Association
Noel S. Weiss, M.D.	Society for Epidemiologic Research

TABLE II:

CASE-CONTROL STUDIES OF ESTROGEN USE AND ENDOMETRIAL CANCER*

First Author	Site of Study	Relative Risk Reported in Abstract
Smith[22]	Seattle	4.5
Ziel[23]	Los Angeles	7.6
Mack[24]	Los Angeles	8.0
McDonald[25]	Rochester	4.9
Antunes[26]	Baltimore	6.0

*Adapted from the paper presented by Dr. Hulka

TABLE III:

CASE CONTROL STUDIES OF ESTROGEN USE AND BREAST CANCER*

First Author	Number of Cases	Number of Controls	Relative Risk
Boston Collaborative Drug Surveillance Program[17]	51	774	1.0
Henderson[30]	308	308	0.8
Craig[31]	134	260	1.0
Mack[32]	111	444	1.6
Casagrande[33]	47	31	3.1
Sartwell[34]	284	367	0.8
Wynder[35]	785	2231	1.1
Brinton[36]	405	1156	1.0

*Adapted from the paper presented by Dr. Hulka

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GERONTOLOGICAL NURSING

A Statement
Submitted to
The National Advisory Council on Aging

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Preface

In January, 1980, I agreed to present a statement on the current status of geriatric/gerontological nursing to the National Advisory Council on Aging at its October, 1980 meeting. The charge I was given turned out to be more encompassing than I had anticipated:

> This report, somewhat comprehensive in scope, is to contain, inter alia, current status of nursing research and clinical nursing in the field of aging; available curricular materials and publications in the field of gerontological and geriatric nursing; clinical investigation in geriatric nursing; information and data on nurses in the U. S. holding the Ph.D. degree and their fields of specialization; a review of the problem of numbers and qualifications of persons in both research and clinical nursing in the fields of geriatrics and gerontology; status of professional nursing care vs. untrained aides in U. S. nursing homes; etc.

My objective in preparing this statement was to provide the Council members not only with the information requested but also to give them a reasonably complete picture of gerontological nursing and gerontological nursing research.

In addition, I have included some recommendations regarding the kinds of support which, if made available, would enable nursing to expand the scientific foundation upon which to build gerontological nursing practice.

Gerontological nursing, very simply defined, is the nursing specialty concerned with the nursing of older adults. As is true of any specialization within a profession, the specialization is easier to understand if one has a basic understanding of the parent profession. Therefore, this paper will first speak briefly to nursing, its research and education before addressing gerontological nursing, gerontological nursing research, and gerontological nursing education.

Background

Although there have always been persons who cared for the sick, nursing in a real sense began in the second half of the nineteenth century. Florence Nightingale, in an 1892 memorandum to the Privy Council, stated "For nursing was born but about thirty years ago. Before it did not exist, tho' sickness is as old as the world." By this statement, Miss Nightingale dates the beginning of nursing from the establishment in 1860 of the First Training School for nurses at St. Thomas's Hospital in London. Mrs. Bedford Fenwick, a contemporary of Miss Nightingale and founder of many professional nursing organizations including the International Council of Nurses, also believed that nursing began at that time but thought it should be traced to a different origin. At an 1890 meeting of the Rural Nursing Association, Mrs. Bedford Fenwick outlined the improvements in nursing during the previous twenty years and stated that these really dated from the publication of Miss Nightingale's "Notes on Nursing" which, for the first time, laid down the principles of nursing and which showed "the cardinal dependence of the work upon clearly defined scientific rules" (Hector, 1973, ix).

Nursing: Definition

Nursing, as an emerging profession, has been striving to define the nature of the discipline for decades. A variety of definitions have been offered but rather than choosing one as the definition of the nature of nursing, at this point in time it might be more profitable to look at the commonalities or recurrent themes that have appeared in the literature. Donaldson and Crowley (1978) identified three general themes which have recurred with consistency in the work of nurse scholars from Nightingale to those writing at the present time. These are (1) concern with principles and laws that govern the life processes, well-being, and optimum functioning of human beings--sick or well; (2) concern with the patterning of human behavior in interaction with the environment in critical life situations; and (3) concern with the processes by which positive changes in health status are affected (p. 113). These themes, then, can be viewed as the essence or core of nursing practice.

Nursing Research: Definition and Nature

The three major themes also suggest the boundaries of an area for systematic enquiry within nursing (Donaldson and Crowley, 1978). Unfortunately, the need for nursing research is not immediately evident to some persons outside of nursing. In fact, some might even say that there is no such thing as nursing research, only research done by nurses. However, the 1977 Report of the National Academy of Sciences' Committee on a Study of National Needs for Biomedical and Behavioral Research

Personnel contains the following statement regarding the nature of nursing research (National Academy of Science, 1977, p. 152):

> Nursing research focuses on the role of nursing care in the prevention of illness, care of the sick, and the promotion and restoration of health. Although it relies upon and utilizes the substantive scientific information and methodology provided by the other biological sciences, it differs from those other scientific areas in that it focuses on their relevance to nursing rather than other aspects of health care.
>
> By tradition, natural inclination, and previous training, nurses have a special interest in and potential competence for research in this area and it is natural that they should wish to play a part in its advancement. Nurses view health problems differently and direct the results of their research to quite different audiences than other biomedical and behavioral scientists. Hence, nursing research is usually done by nurses. The Committee therefore concurs that nursing research is properly regarded today as a distinct area of scientific inquiry.

Although nurses may utilize information from other disciplines, as Donaldson and Crowley (1978) point out, it is not possible to simply "borrow" theory of knowledge from other disciplines because theory or knowledge is properly understood only in the context in which it was developed. Therefore nursing research may study the same phenomena as other disciplines but the studies are undertaken from a nursing perspective.

The Commission on Nursing Research of the American Nurses' Association (1980) offered the following definition of nursing research:

> Nursing research develops knowledge about the health and promotion of health over the full life-span, care of persons with health problems and disabilities, and modalities to improve the quality of life for individuals regardless of health state, but particularly for groups such as the frail elderly, the chronically ill, and the terminally ill. These foci complement biomedical research, which is primarily concerned with causes and treatments of disease.
>
> Research done by nurses includes both laboratory and clinical studies. Fundamental knowledge about the mechanisms underlying health and its promotion and about living with illness are investigated in order to derive clinical interventions.

> The complexity of nursing research and its holistic scope often require scientific underpinning from several disciplines. Hence, nursing research cuts across traditional academic/research lines, and its research methods are drawn from several fields.

In addition, the Commission suggested that priority should be given to nursing research that would generate knowledge to guide practice in six areas: (1) promoting health, well-being, and competency for personal care among all age groups; (2) preventing health problems throughout the life span that have the potential to reduce productivity and satisfaction; (3) decreasing the negative impact of health problems on coping abilities, productivity, and life satisfaction of individuals and families; (4) ensuring that the care needs of particularly vulnerable groups are met through appropriate strategies; (5) designing and developing health care systems that are cost-effective in meeting the nursing needs of the population; and (6) promoting health, well-being, and competency for personal health in all age groups.

Nursing: Education

That people outside of nursing may be confused about just who is or is not a nurse is understandable given the various ways a person can become a registered nurse. Adding further confusion is the number of non-professionals--aides, assistants, orderlies--whose function is to assist the nurse as well as the presence of the licensed practical nurse who works under the direct supervision of the professional nurse and functions in an intermediate capacity between the professional nurse and the non-professional assistants. Because all of these persons have direct contact with patients, to the uninitiated they all may be perceived as nurses and the care they give be labeled nursing care.

The preparation for persons electing to enter the nursing profession, unlike most other professions, can be obtained in one of three types of schools: diploma (traditionally a three-year program attached to a hospital), associate degree (a two-year program most frequently found in community or junior colleges), and baccalaureate degree (usually a four-year program which is part of a college or university). Successful completion of one of these three programs gives the student the right to sit for state board examinations. Successful completion of the examination confers the right to use the title "registered nurse." (It should be noted that in this paper "professional nurse" is being equated to "registered nurse" regardless of the educational program completed; the use of the term "professional nurse" is currently being debated within nursing.)

Since approximately the second decade of this century nursing has been steadily moving toward more academic preparation for its professional members. Currently there are programs especially designed to assist professional nurses from diploma and associate degree programs obtain baccalaureate degrees as quickly and efficiently as possible. Although there are many reasons why professional nurses might seek a baccalaureate degree in nursing, the reason which will concern us here is that graduation from a baccalaureate program which has been approved by the National League for Nursing is required for admission into almost all master's degree programs in nursing.

At the present time there are over 100 programs which offer master's preparation in nursing. Some of these are professional programs, others are academic programs. Early master's level nursing programs focused on preparation in functional areas and were heavily weighted toward courses in curriculum and instruction, principles and methods of teaching or administration, and courses in test construction and the like (Brower, 1977). Today, master's curricula in nursing offer courses in research, advanced clinical nursing, and electives to support a major as the central focus. Additionally, many graduate programs offer the student the option of the expanded role (i.e., nurse practitioners, nurse clinician) in conjunction with the master's degree.

As might be anticipated, opportunity for doctoral education in nursing is more limited than is master's education. At the present time there are twenty-one schools offering doctoral preparation in nursing; one additional school plans to admit students Fall, 1980. Of the 21 doctoral programs, fourteen were established after 1970. One of the programs offers a Doctorate of Education (Ed.D), seven offer a Doctor of Nursing Science (D.N.S. or D.N.Sc.) and thirteen offer the Doctor of Philosophy (Ph.D.). Seven schools specifically state that their programs have a clinical nursing research emphasis. Because many nursing doctoral programs are new and consequently small, few nurses are graduated annually with doctorates in nursing. According to a recent report of the American Association of Colleges of Nursing (1978), fewer than 30 nursing doctorates were granted in 1977 and only approximately 50 in 1978.

Nurses have always had available to them enrollment in doctoral programs in non-nursing disciplines; in fact, most doctorally prepared nurses have gotten their degrees in a field other than nursing. For a variety of reasons, the most common discipline has been education or one of its variants (educational administration, higher education, curriculum and instruction, etc.). During the period of the Nurse Scientist programs, many nurses received their degrees in fields other than education but still not in nursing. Given the small number of doctoral nursing programs, it is anticipated that the trend begun under the Nurse Scientist program will continue for some time to come.

It should be evident from this brief overview of nursing that many aspects of the profession are still fluid. Some, such as the definition of the nature of nursing, may remain that way. Others, such as level of entry into practice, may be resolved in the near future. It should also be clear that nursing is moving away from a task orientation toward a process orientation and that that movement is accompanied by increased attention to the academic preparation of those who elect to join its ranks.

Gerontological Nursing

As a specialty, gerontological nursing fits within this broader context of nursing. That is, a nurse must first be knowledgeable and skilled in general nursing before she can add the knowledge and skills required for gerontological nursing. As Wells (1979, p. 189) recently stated

> Because there is little awareness of the breadth and depth of modern gerontological nursing, many nurses believe it to be simply a kindly attention to the bedfast old. In their ignorance they foster a passive acceptance of some of the most complex care problems in nursing.

What is gerontological nursing? If the three themes of Donaldson and Crowley (1978) presented earlier as representing the essence or core of nursing practice are accepted as a definition of nursing, then gerontological nursing, because it is concerned with the nursing of older persons, would be concerned with the principles and laws that govern the life processes. well-being, and optimum function of older persons--sick or well;

the patterning of older persons' behavior in interaction with the environment in critical life situations (coping processes, adaptation, supportive and non-supportive environments), and the processes by which positive changes in the health statue of older persons are affected.

The Division of Gerontological Nursing Practice of the American Nurses' Association (1976) gives this definition of gerontological nursing:

> Gerontological nursing is concerned with assessment of the health needs of older adults, planning and implementing health care to meet these needs, and evaluating the effectiveness of such care.

The Division amplifies this definition by adding

> [In gerontological nursing] Emphasis is placed on maximizing independence in the activities of everyday living and promoting, maintaining, and restoring health. The learning aspects of health care have significance in achieving and maintaining a level of wellness consistent with the limitations imposed by the aging process and/or chronic illness. Gerontological nursing strives to identify and use the strengths to maximize independence. The older adult is actively involved to the fullest extent of his/her capabilities in the decision making which influences everyday living.

To this Wells (1979, p. 190) adds

> Basic to gerontological nursing is the belief that the elderly individual has the right and freedom to choose his individual level of physical functioning, social role, and, when the time comes, a death with dignity and comfort.

It should be pointed out that there is a substantive distinction between gerontological and geriatric nursing even though these terms frequently have been used interchangeably. Gerontological nursing is the more inclusive term and encompasses the nursing of all elderly persons regardless of their health status. Geriatric nursing refers specifically to nursing the ill elderly. In the 1950's and 60's most of the nurses providing care to the elderly were involved with the ill elderly so it was logical that the term "geriatric nursing" rather than gerontological nursing was used in the nursing literature. However, "gerontological" is the term which most accurately reflects nursing's holistic view of man. The most recent standards committee of the American Nurses' Association's Division of Gerontological Nursing Practice, for example, changed the title of the standards from "Standards of Practice for Geriatric Nursing" to "Standards for Gerontological Nursing Practice." The new standards were developed to be used in a variety of health care settings rather than just in institutional settings; thus the change in title reflects both the change in philosophical orientation and in the content of the standards. Not all of the nursing care given to older persons is provided by gerontological nurses. Consequently the education of all professional nurses, in addition to gerontological nurses, should be examined if we are to understand nurses' preparation for caring for older persons.

Professional (RN)

There are currently approximately 1,400 basic (entry level) nursing programs in the United States; approximately 23.9% of these are baccalaureate programs, 44.9% are associate degree, and 31.1% are diploma programs. Of the 74,536 1974-75 graduates of these programs, 27.1% were graduated from baccalaureate programs, 43.8% from associate degree programs, and 29.1% from diploma programs (ANA, 1977). The movement of nursing toward more academic preparation for its entry level nurses is illustrated by comparing the above figures with those of 1965-66. The percentages of graduates from each type of program that year were 15.7, 9.5, and 74.8%, respectively.

According to Brower (1977, p. 41) until recently gerontological nursing has received scant attention from nurse educators. A study done in the early 1960's (Elmore, 1964) found only a limited number of schools were teaching any aspect of geriatrics or gerontology as part of their basic program. And even when it was taught, the content was interjected into the curriculum in a haphazard way. The 1971 survey conducted by Senator Moss of the Senate Select Committee on Aging (DHEW, 1975) showed the situation had improved slightly: 5.3% of the programs indicated they included--or planned to include--geriatrics as a specialty. Another 53.5% stated that they integrated the geriatric/gerontological concepts into a more general course on human development, and 26.3% indicated their programs allowed students to have some type of experience in nursing homes. However, the findings reported in this survey are suspect because less than half of the 1,072 schools responded.

The most recent survey of basic nursing curricula, an unpublished study conducted in 1976 by the American Nurses' Association, revealed that 9% of the schools required courses in gerontological nursing for their students and an additional 5% made these courses available to interested students. Ninety-seven percent of the schools stated that they integrated the content into their basic curriculum although 59.4% indicated that they spent less than 15% of the classroom time on principles of care of the elderly. This survey included in its inquiry a question on the preparation of nurse educators to teach the gerontological/geriatric components of curricula. Over 94% of the faculty said they had learned the content through self-study, 71.9% had attended workshops in the field, and 60.9% had enrolled in formal continuing education offerings.

Because the vast majority (95.7%, according to Roth, 1977) of the professional nurses currently employed are basing their practice on entry level preparation, it is essential that (1) all current graduates of basic nursing programs have both didactic and clinical learning experiences with normal aging, chronic illness, and age-related diseases; and (2) continuing education in gerontology for practicing nurses be available to those who were graduated from programs which had no gerontological/geriatric component and/or to keep nurses informed of current developments in the field. The Nurse Training Act of 1975 gave special emphasis to the problems of health care for the elderly and authorized support for special projects and training programs in this area. Eighteen projects/programs with this thrust have been funded. Ten of these have focused on continuing education and three dealt with adding gerontological/geriatric content to basic nursing curricula. Four of the remaining five programs were directed toward post-baccalaureate training and the fifth focused on training of geriatric nursing assistants.

The movement of nursing toward including gerontological/geriatric emphasis or courses into the curricula of basic programs has been shown.. However, the content of those courses is not known. Some schools have described their courses in published articles and materials (see Appendix A for examples); most have not done this. Because college texts in a given field may reflect the content of courses in that field, one might be able to ascertain at least some of the issues being covered in these courses.

The first nursing textbook for care of the elderly, Kathleen Newton's Geriatric Nursing (C. V. Mosby Co.), was published in 1950. Since 1970 the number of texts has increased greatly (see Appendix G for examples of textbooks). Although each text may place more emphasis on one aspect of gerontological nursing than on others, there is content common to almost all texts. Burnside's Nursing and the Aged (1976) is illustrative of that common content. Her text is divided into the following parts:

Aging and Nursing - introduction, philosophy of aging;
The Normal Aging Process - psychology, cognition, developmental tasks, biological theories, changes in reproductive system, nutrition;
Deviations of the Aging Process: Geropsychiatry - mental health, acute and chronic brain syndromes, depression and suicide, selected therapies for use with the aged;
Deviations of the Aging Process: Pathophysiology - cardiopulmonary, renal, digestive muscoloskeletal, sensory;
The Nursing Process - assessment, intervention, goals, preventive measures, home assessment, community resources;
Social Forces and Aging: Implications for Nursing - retirement, ethnicity, environment, religion; and
Research in Aging.

If the content of gerontological nursing courses does parallel that of the textbooks, then it would seem as if students who enroll in these courses at the basic education level should have received at least an overview of the problems associated with providing nursing care to the older adult.

Determining the status of gerontological nursing continuing education offerings is even more complex. Continuing education in nursing is most often considered to be a planned learning experience beyond a basic nursing educational program. This could be in-service education/staff development or the more usual forms of courses, seminars or workshops. Adding to the problem is the multiplicity of education providers. Particularly since continuing education for license renewal has been made mandatory in approximately 25% of the states and is before the legislatures of many other states, there has been a proliferation of sponsoring organizations, both profit and non-profit.

Few continuing education programs have been published. One which has been published (Zerbe and Hickey, 1975) deals with the education of professional nurses to retrain the self-maintenance skills of the elderly. Another (Hedman et al, 1976) sought to determine if the knowledge acquired in a continuing education course would impact upon clinical practice. (They found that it did.) There has been at least one survey of the number of care facilities having ongoing staff development programs. This survey, conducted in 1975 by the U. S. Public Health Service's Office of Nursing Home Affairs, found that just over 80% of the facilities reported having some type of staff development program.

It was stated earlier that not all of the care given to the elderly was provided by gerontological nurses and thus we examined the gerontological/geriatric component of basic nursing programs. If we focus on the five percent of the elderly who are institutionalized at any given time and the persons from whom they receive their care, a still different picture emerges. It has been estimated that between 80% and 90% of the care required by these elderly persons is provided by non-professional personnel--nursing aides/assistants and orderlies.

Non-Professional Personnel

The training required of nursing aides/assistants and orderlies varies from none to approximately 160 hours. Only three states--Minnesota, Iowa and Oregon--require a specific training program for nursing assistants in nursing homes; nine additional states have "endorsed" specific curricula. It is reasonable to conclude from this that in at least 38 states aides and orderlies in nursing homes have little or no training to prepare them to work with the elderly.

The necessity of providing training for the non-professional personnel in nursing homes is recognized by persons both within nursing and outside of it. As stated earlier, one of the eighteen projects/programs funded under the Nurse Training Act of 1975 focused on this aspect of training. In 1979 three additional projects funded under the health care for the aging provision of the Nurse Training Act were concerned with the training of aides/assistants and orderlies.

Additional training for non-professional personnel alone will not solve all of the problems currently rampant in many nursing homes. Although it is crucial, a recent report from the Committee on Skilled Nursing Care (ANA, 1975, pp. 42-43) stated that

> More well-planned programs . . . must be coordinated with nursing home employment process and policies in order to make a difference in training results.
>
> Emphasis needs to be given to job satisfaction. . . . The registered nurse remains the leader of the nursing team as well as the role model and teacher of other levels of nursing personnel (italics added).

If the professional (registered) nurse is to carry out this responsibility, it is obvious that her own level of gerontological nursing knowledge needs to be high. This reinforces the need for a strong gerontological nursing component within all basic nursing programs and the need to have gerontological nurses, those with specialized preparation in nursing of the elderly, on the staffs of nursing homes. It also speaks to the importance of continuing education offerings in gerontological nursing for professional nurses as well as non-professional staff.

Nursing, however, has a paucity of nurses--educators, practitioners, and researchers--with specialized knowledge and clinical practice in gerontological nursing. Therefore, it is imperative that priority be given to graduate preparation for gerontological nurses.

Graduate Preparation/Post-RN Training

As a specialty within nursing, gerontological nursing builds upon the knowledge and skills obtained in basic nursing programs. Therefore, although graudate and post-RN gerontological nursing programs vary in program title; entrance requirements; length of study; and program content, they all require that entrants be registered nurses. They also are all located in collegiate institutions. At the present time there are two types of programs which prepare professional nurses for specialization in gerontological nursing: certificate and graduate programs. Here, too, the move is toward more academic preparation so the number of certificate programs is decreasing gradually.

The specific knowledge and skills taught in a program will vary with the program's philosophy. However, graduates of these programs, regardless of their titles, are all prepared to function in an "expanded role." This role includes (1) working collaboratively with physicians and other health care professionals to identify and meet the health care needs of older persons and (2) making independent decisions about the nursing care needs of patients. Nurses who function in this expanded role also assume responsibility for their acts and are accountable for them.

Certificate programs typically do not require that a student possess a baccalaureate degree for admission. The programs vary in length from 8 - 12 months and have 4 - 6 months of didactic instruction which may be taken concurrently with the 4 - 7½ months of clinical preceptorship. The suggested ratio of didactic to clinical experience is 1:2 or 3.

There are currently nine schools which offer a program leading to a certificate with gerontological/geriatric nurse practitioner specialization (see Appendix B). According to an ANA survey conducted in 1978, these programs had graduated 213 nurse practitioners. Excluded from these numbers are adult nurse practitioner and family nurse practitioner programs and graduates even though these, too, may have a gerontological/geriatric focus.

Master's programs with specialization in gerontological nursing have grown significantly since the early 1970's. The American Nurses' Association (1980) reports that there currently are 23 programs that offer a master's degree with specialization in gerontological nursing (see Appendix C). The telephone survey conducted by the ANA in 1978 indicated that 150 nurses were graduated from these programs.

As with the certificate programs, there is a great deal of variability among the master's programs in terms of length (80% require two years for completion) and focus (practice, teaching, administration). However, many programs seem to have adopted what Wells (1979) calls a social definition of health and illness; i.e., a person is well when, despite having one or more pathological conditions, he can do those things that are necessary and meaningful in his life. This approach to the nursing of the elderly focuses on the older person's identification of needs and problems; the skills required of the practitioner include observation and interviewing as much as the more task related skills traditionally associated with nursing. The nurse herself then becomes an instrument to be used in nursing the elderly in much the same way she might use a stethescope or a sphygmomanometer.

Most graduate programs also have a research component included in their curricula. In some instances this is restricted to didactic instruction but in many programs it also includes the design and execution of a research project. Thus graduates of these programs, while perhaps not independent researchers themselves, are knowledgeable consumers of research and are very capable of delineating areas of nursing practice in need of research.

It is of interest to note that in 1973 the American Nurses' Association inaugurated certification within gerontological/geriatric nursing "to establish ways to provide formal recognition of personal achievement and superior performance in nursing." Anyone who can provide evidence of completing a minimum of 40 contact hours of continuing education in gerontological/geriatric nursing within the preceding two years is permitted to apply for certification. Certification itself is based upon (1) successful completion of a written assessment of knowledge, (2) demonstrated competence in clinical practice, and (3) endorsement by colleagues. Seventy-four nurses were certified the first year; as of March, 1980, there were 287 certified nurse gerontologists and three certified gerontological nurse practitioners (Bunke, 1980).

Certification appears to be a significant development within gerontological nursing; however, its full impact cannot be known for some time to come.

One of the major problems facing graduate programs in gerontological nursing is that of adequately prepared faculty. The majority of persons teaching in these programs have obtained their knowledge through self-study and/or continuing education. As of 1978, only two persons teaching in these programs held doctorates with specialization in gerontology or gerontological nursing (ANA, 1978). Although more recent data are unavailable, it may well be that this number has increased somewhat for there are now sixteen doctorally prepared nurses with specialization in one of those two areas.

Doctoral

Many in collegiate institutions view doctoral education primarily as a means of preparing persons to teach in collegiate programs. However, by tradition the doctorate, particularly the Ph.D., is a research degree. Doctoral preparation within nursing is no exception to this tradition and is seen by many nurses as the way to prepare nursing scholars with the research vigor and theoretical knowledge necessary to advance the empirical bases for nursing.

As stated earlier in this paper, at the present time there are twenty-one doctoral programs in nursing with the twenty-second scheduled to admit its first students this fall (see Appendix D). Four of the twenty-one schools--University of Colorado, Case Western Reserve, University of Illinois, and the University of Michigan--offer a doctorate in nursing with a focus on gerontological nursing. The University of Wisconsin, which was scheduled to admit doctoral students this fall, also anticipates having a gerontological nursing focus. Two additional schools which have existing doctoral programs, Indiana University and the University of Maryland, are developing gerontological nursing components for eventual inclusion in their programs.

The most recent survey (ANA, 1980) revealed that there are presently 2,348 doctorally prepared nurses. Although this is a very small number when one considers the total number of professional nurses (estimated at over one million [Roth, 1977]), it is an increase of almost 500 over the nubmer reported in the 1972 survey. Seventy-nine different majors are reported by these nurses; ten majors have "nursing" in their titles, another six are in the area of health or public health (see Appendix E). That persons would elect to study in such diverse fields as biophysics, human ecology, political science and zoology and yet remain within nursing shows both the strength of the persons's commitment to the profession and the diversity of interests of nurses.

The 1980 survey also revealed that 5.3% (124) of the doctorally prepared nurses reported having held post-doctoral appointments. Over half of these (77) were in the last five years; another twenty-two were between 1970 and 1974.

Of particular interest is the fact that sixteen doctorally prepared nurses reported that gerontology or gerontological nursing was the focus of their doctoral study. The recency of this direction for nurses is demonstrated by the fact that two received their degrees in 1969 and one other received hers in 1965; six of the remaining thirteen received their degrees in 1975 or later. In addition to these persons, two other doctorally prepared nurses reported holding post-doctoral appointments in gerontology in 1978.

A third area of inquiry in the ANA 1980 survey was that of current research or academic activities. Here the figures are even more encouraging: 159 or almost 7% of all doctorally prepared nurses reported gerontology (92), aging (41) or long-term care (26) as the area of their current activity.

The recently completed survey of these doctorally prepared nurses, of course, can only describe what is; it cannot speak to the future. However, given the existing movement within nursing toward more academic preparation for its members and the current increase in numbers of doctoral programs in nursing, it would seem reasonable to predict a continuing increase in the numbers of doctorally prepared nurses. However, because so many of the doctoral programs in nursing are relatively new (fourteen of the twenty-one existing programs began after 1970) and consequently small, it would also appear reasonable to assume that many nurses will continue to receive their doctorates in disciplines other than nursing. With the increased attention being given to the elderly by academicians and the general public, it might also be predicted that increasing numbers of nurses will direct their study toward the nursing of older persons.

Before we move into the area of gerontological nursing research, it should be stated that much of the growth in both the numbers and quality of programs for the education and training of professional and non-professional nursing personnel is a result of the encouragement and support of the Division of Nursing (Bureau of Health Manpower, Health Resources Administration, U.S. PUblic Health Service). Many of the programs referred to earlier have received support from them. An example of that support is the fact that in 1979 eight schools received funding to provide nurse practitioner training in primary care for elderly patients and sixteen schools had advanced nurse training projects funded that focused entirely or in part on gerontological nursing.

Gerontological Nursing Research*

Despite the fact that Florence Nightingale had systematically collected data about hospital conditions during the Crimean War and had used those data to bring about change, it was not until the middle 1940's and early 1950's that many in nursing saw the importance of research for the improvement of practice. Most thought that the way to improve nursing was to focus on improving education. However, nursing soon realized that without the knowledge to teach, improved teaching methods and curricula would not improve nursing. And so at the present time it would be difficult to find a nurse who would seriously question the need for an expanded research base upon which to build nursing practice, theory, and education.

The numbers of published nursing research studies has grown steadily over the years as has the volume of gerontological nursing research. An analysis of the articles published in Nursing Research, the first journal devoted exclusively to nursing research but not the first to publish research, shows this increase. In its first eight years of publication (1952-1959) one article on nursing of the elderly was printed--in Volume 1, Number 1. During the next ten years (1960-69), nine articles were published; nineteen gerontological nursing research studies appeared in the journal in 1970-79.

Gerontological nursing research owes much of its development to the

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*This review is based largely on a published listing of research funded by the Nursing Research Branch of the Division of Nursing, Gunter and Miller (1977), Robinson (1976), Brimmer (1979), a computerized search of nursing research published between 1972 and 1980, and a review of the materials published in the Journal of Gerontological Nursing.)

Division of Nursing Resources of the United States Public Health Service which was established in 1948 to carry out research and consultation in nursing. The first funded project in the area of nursing gerontology began in April, 1957, just two years after nursing received its first federal government supported grants for extramural research. A group of graduate nurses studied nurse-patient interaction and environmental factors affecting nurse-patient relationships (Brown et al., 1957). Since then the Division has funded additional projects focusing on the following topics: the personalization of older patients, attitudes of caretakers, facts on nursing homes, nursing needs of the chronically ill elderly, nursing personnel and dying patients, and nurse awareness and psychosocial function in the aged. More recent gerontological research funded by the Division of Nursing includes job performance in nursing homes, living skills of the nursing home resident and the care-cure problem of dying in teaching hospitals (Brimmer, 1979). (A listing of the projects funded by the Division of Nursing can be found in Appendix F.)

The American Nurses' Association has also contributed greatly to the advancement of gerontological nursing research. With the aim of supporting and promoting nursing research and disseminating research findings, the ANA established the American Nurses' Foundation in 1955. During the next 20 years the ANF awarded about 80 grants for research projects totally over one-half million dollars. Brimmer (1979) states that between 1975-1978, 25 awards were made at an approximate cost of $120,000.. Those studies concerned with the aged included: correlates of psychological health and longevity, illness crises in the families of the aged, care for dying patients and their families, interaction between nurses and dying patients, widow bereavement, and bowel and bladder incontinence.

Before reviewing some of the gerontological nursing research literature, it might be appropriate to point out some of the problems that one encounters in attempting to do a thorough review. First, one can be overwhelmed by sheer numbers. Our computerized literature search (Medline) for just seven and one-half years produced more than 700 citations. It is undoubtedly true that not all of these were nursing research studies but they all were concerned with gerontological/geriatric nursing. In addition, you will recall that a) nurses have received their degrees in a variety of disciplines and b) nurses frequently examine phenomena of interest to persons in other disciplines but from a nursing perspective. Because of this, it is possible (and perhaps probable) that nursing research could be published in other than nursing/health care journals (e.g., sociological or psychological publications). Had we searched that literature, it is unknown how many additional references we would have found. It is primarily for these reasons that our review draws heavily on the research reported in Nursing Research and the Journal of Gerontological Nursing, one of the principal journals read by large numbers of gerontological nurses.

The gerontological nursing research reviewed here is broken down into five substantive areas: (1) psychosocial characteristics of the elderly; (2) patient variables influencing care; (3) direct patient care; (4) healthcare delivery systems; and (5) characteristics of the caretakers of the elderly. We have further divided some areas into special foci and have presented several of the more noteworthy research findings. The reader is also referred to the reviews of Basson (1967), Robinson (1976) and Gunter and Miller (1977).

Psychosocial Characteristics of the Elderly

A major area of research has been that of psychosocial characteristics of the elderly. In fact, the first gerontological nursing study published in Nursing Research (Mack, 1952) was concerned with the adjustment of the chronically ill elderly. In studying the elderly's adjustment to common life events, Muhlenkamp (1975) reported that they saw change as more stressful than did younger people. However, the elderly did not believe retirement or death of a spouse needed as much adjustment as did the younger group sampled. Another study (Fussel, 1969) reported the following factors as important to adjustment to nursing homes: enjoyment of food, anticipation of visits from families and friends, and interest in one's own physical well-being.

Several studies have focused on the leisure time activities of the elderly. Preferred activities were predominantly passive (such as watching television & listening to the radio), individual rather than group, and religious (Wang, 1962; Lemmon and Pieper, 1980). Other activities included reading, walking or riding, visiting friends and letter writing (Wang, 1962). Wang (1962) concluded that, for the most part, the elderly engaged in activities that were easy to do, required little thought or energy, and could be done alone. Levine (1969) found that even though club activities were available to the elderly only 5% were members. Even though the elderly seem to exhibit a preference for solitary activity, Francis and Odell (1979) found a relatively low incidence of loneliness (9.5%) among institutionalized elderly persons.

Nurses have also focused their research efforts on the problem of dependency in the elderly. The consensus in the literature is that dependent behaviors of institutionalized elderly are most often met with positive verbal reinforcers by the staff, who provide no response to independent behaviors. Thus, dependent behaviors are reinforced while independent behaviors are extinguished (Lester, 1978; Baltes, 1979). The investigators emphasized the importance of increased positive reinforcement of independent behaviors.

The impact of social isolation on the elderly is a fourth topic that has received research attention. Studies have reported social isolation as a major problem for the elderly (Managan et al, 1974; Franck, 1979). Evans (1979) found that higher levels of mental health were associated with intact social support systems. Other studies reported disengagement in the elderly as a frequent response to decreased social interaction (Levine, 1b69; Gioiella, 1978).

Patient Variables Influencing Care

Nurses have also studied the characteristics and problems of the elderly that affect the kind and quality of care provided. Ambulation is a common problem for the elderly person. Schwartz et al. (1963) found that difficulty in walking (and in thus getting to the grocery store) was associated with poorer diets. Foot problems and accidental falls are also frequently experienced by the elderly. The most common foot problems reported were corns, calluses, toenail problems, bunions and edema; these frequently were associated with medical problems such as arthritis, circulatory problems, heart disease and diabetes (Schank, 1977). Unacceptable shoes also contributed to foot problems (King, 1978). Falls among the elderly occurred in the well-adjusted patient who was not under the influence of medication (Feish, 1978). Restraints did not entirely protect the elderly against falls; it appeared that lack of familiarity with surroundings caused frequent falls. Additional problems of the elderly that have implications for nursing are slowed reaction time and confusion (Greenberg, 1973; Michols, 1970; Williams, 1980).

The elderly patient's knowledge about self-care is another important variable in his/her care. In assessing the health knowledge of elderly women, Kerscher (1978) found them to be knowledgeable about the changes in their bodies, the effects of exercise, proper nutrition and the problems normally experienced by elderly women.

Other studies have investigated the elderly person's knowledge of medications. Neely and Patrick (1968) reported medication errors to be predominantly those of omission and inaccurate knowledge of the medication. Lundin (1978) found that the elderly were given inadequate directions about the time and purpose of the drugs they were taking. Also, they were not sure when to discontinue taking the drug. Another common occurrence is obtaining prescriptions from more than one physician which often leads to potential drug-drug interactions (Lundin, 1978; Requarth, 1979). Another study (Dittmar, 1977) suggested early administration of sleep medication caused negative behavior and hindered improvement in daily activities.

Direct Patient Care

A third major research trend is the study of different interventions to meet the needs of the elderly. Several studies have examined the use of operant conditioning in changing problematic behaviors. In attempting to change incontinent behavior in the elderly, Carpenter and Simon (1960) studied the effect of habit training on two different rewards: social approval and material rewards. The greatest decline in incontinence occurred in the materially rewarded group although the socially rewarded group also evidenced a decline in incontinence. The habit training only group showed a significant change but was unable to maintain it. Beltes (1975) also used operant conditioning to modify anti-social behavior. Positive reinforcement of desired (non-screaming) behavior dramatically reduced the occurrence of screaming.

Another study which showed change in patient problem behaviors was done by Wichita (1977). Holding the high fiber diet constant, she examined the impact of form of feeding (self, staff) on bowel habits. Both groups showed a decrease in the numbers of enemas or suppositories required. However, the staff fed group had a 62.5% decrease in incontinence compared to no decrease among the self-fed group. Wichita attributes the change to increased staff attention. In an earlier study, Keller and Schaughnessy (1963) had found that nursing home nurses generally identified and met physical care needs well but frequently failed to identify and thus to meet the psychosocial needs of the patients.

Another area of research interest has been the use of structured orientation and resocialization with confused elderly patients. Whereas Hogstel (1979) found no measurable change in the mental status of her group after experimenting with orientation, Veelkel (1978) reported significant improvement in mental status after using a resocialization approach (i.e., open discussion in which participants discussed their personal experiences).

Other interventions have attempted to enhance the quality of life and to reduce dependence in elderly patients. Carlson (1968) reported an increase in life satisfaction of elderly female patients when sensory input was increased. Provision of a sociotherapeutic atmosphere which emphasized prevention of alienation and which promoted normative daily activities resulted in a higher discharge rate (from institutionalized care) and a lower mortality rate (Anderson, 1967). Gray and Stevenson studied the impact of a rehabilitative approach in the care of elderly patients. They stressed self-feeding, congregate meals, bowel and bladder training, remotivation and orientation programs and family education/self-help groups. Improvements were evident in almost every area. Similar success was reported by Mastrangelo (1965) in teaching activities of daily living to a group of elderly patients.

Additional studies have addressed specific patient problems. DeWalt (1975) studied the effect of the application of oral hygiene on oral mucose. Results indicated significant improvement in salivation, tongue color, moisture of the tongue and palate, condition of the membranes and lip texture. The relative effectivness of lemon juice and glycerine and normal saline as oral hygiene agents was studied by Drimmelen and Rollins (1969). Both agents were found to be effective but the normal saline was found to be less drying.

Still other studies have investigated the following topics: the impact of individualized nursing interventions on senile patients, the effect of nurse-patient interchange on the status of elderly psychotically depressed patients, and the effect of expanded speech and self-pacing in communicating with the elderly. Health-care teaching has also been the focus of a number of studies.

Health-Care Delivery Systems

The nursing research literature contains some investigations of health-care delivery systems to the elderly. Sullivan and Armignacco (1979) tested three modes of health care delivery to the elderly living in senior citizen housing. They found the most effective method to be an extensive nursing program (i.e., an outreach program consisting of a public health nurse and on-site diagnostic and treatment services of a medical nurse practitioner). Residents reported more positive perceptions of their own health, learned to respond effectively to health screening programs and more actively sought primary care.

In another study (Schultz, 1977) the adult health nurse practitioner/physician team was found to be more effective and efficient than a physician only in the delivery of primary health-care to the elderly. Overall, patients who received care from the team used more primary encounter time, had fewer hospital days, utilized fewer diagnostic and therapeutic procedures and fewer supportive services, and paid less than did the group receiving care from a physician only.

The most recent study to look at different health care systems was that of Weissert et al. (1980). A randomized experiment, the study was designed to examine the effects of adult day care and homemaker services on a Medicare-eligible population and to determine the impacts of those services on institutionalization and Medicare costs. Differences between experimental and control groups in functional ability, death rate, use of skilled nursing facilities, hospitalization, utilization of other Medicare services, contentment, mental functioning and social activity in addition to costs were investigated. Although the data are not clear cut, they suggest that day care and homemaker services may be additional benefits rather than substitutes for nursing home care. However, there were significantly fewer deaths in the experimental groups and, for the day care group, fewer days in skilled nursing facilities. The experimental groups tended to improve or at least maintain their levels of contentment, mental functioning and social activities. When the cost of the experimental programs was added to those of other utilized Medicare services, the net total Medicare costs were higher for the experimental groups than for the controls.

Characteristics of Caregivers

The final area of gerontological nursing research to be reviewed is that of characteristics of the persons who provide care to the elderly. These studies have focused predominantly on the attitudes of nurses and nursing students toward the elderly. A few studies have looked at the attitudes of other persons who come in contact with the elderly (e.g., physicians, licensed practical nurses, social workers) and at various attempts to change attitude.

Results from the studies on nurses' attitudes toward the elderly, usually defined as endorsement or lack of endorsement of stereotyping of the elderly, suggest that in general nurses hold negative attitudes toward the elderly (Coe, 1967; Dominick et al., 1968; Brown, 1969; Campbell, 1971; Gunter, 1971). Because attitude was believed to influence care given, further attention was given to this area of study. Comparisons between groups of professionals were done; the effects of selected demographic variables were examined; and correlates of more positive attitudes were sought. It was at this point that conflicting findings began to emerge.

Brown (1969) found that nurses' unfavorable attitudes toward the elderly were highly correlated with the following conditions: behavior requiring extra nursing care, noisy behavior, senility, interpersonal problem behaviors (i.e., non-comformity), and inability to perform self-care activities). In contrast, those patients who exhibited socially acceptable behavior and who were socially active elicited positive attitudes from nurses. For those nurses who did not wish to work with the elderly, salary increase or shift preference had little impact (Campbell, 1971).

Younger nurses in nursing homes held more positive attitudes toward the elderly and favored a rehabilitative approach to their care (Stotsky and Rhetts, 1966). According to Taylor and Harned (1978) those nurses younger than 40 had the most positive attitudes. Younger nurses were also reported to have more psychiatric and gerontological training than did the older nurses, who were more oriented toward a custodial care approach (Stotsky and Rhetts, 1966). Education may be an added factor since Taylor and Harned (1978) reported that nursing instructors held more positive attitudes toward the elderly than did their students.

Futrell (1977) found, however, the age and length of service had a positive effect on attitudes; nurses who had worked longer and were older had more positive attitudes. This is in contrast to the findings of Campbell (1971) and Taylor and Harned (1978). Campbell found that nurses with less experience working with the elderly were less willing to accept negative stereotypes about them while Taylor and Harned indicated that nurses with less than 10 years experience in gerontological nurse and those who lived in communities with few elderly had the most positive attitudes.

Gillis (1973) examined the relationship between attitude and selected demographic variables. She reported that age, place of employment, and education seemed to be unrelated to attitude. Brower (1979, 1980) looked at the same variables plus work setting. Using more sophisticated data analysis techiques than had been used in many of the early nursing studies (i.e., step-wise analysis of variance, analysis of covariance, and multiple regression) to test main and interactive effects and cross-break analysis to examine how the interactive effects were operating, Brower's findings suggest that the interactive effects of nurses in agencies, the clients' characteristics, and the organizational milieu strongly affect attitudes.

Research Needs

Even though the numbers of nursing studies on aging and the elderly has increased steadily over the past twenty years, there is much that needs to be done. The research completed provides some initial insights into some of the problems and conditions faced by the elderly, particularly those in institutions. Unfortunately, there are relatively few studies looking at nursing of the elderly in the community or those in short-stay hospitals.

Most of the research that has been done has been either descriptive or correlational in nature. In addition, many studies completed are the only study in that area. Additional studies must be done in order to validate the reported findings.

Another problem is that much of the gerontological nursing research is based on theoretical and conceptual bases derived from the behavioral and social sciences and the physical sciences (Robinson, 1976). While such integration of knowledge from other disciplines is often essential, it is important that nursing develop conceptual frameworks based on the phenomena as they are encountered in nursing practice. Nurses need to integrate their research findings into a larger body of scientific knowledge which will form the basis of clinical gerontological nursing practice. In order to build such a body of knowledge, there must be more replication studies which use rigorous and systematic research designs and methodologies (Robinson, 1976).

The lack of rigorous design and methodology was also pointed out by Gunter and Miller (1977, pp. 212-18). The studies they reviewed revealed the following problems:

> . . . a lack of evidence of sound survey design; an absence of critical review of theories on which investigation is based; inadequate, nonrandom, nonrepresentative samples leading to questionable reliability and validity; an absence of evidence of pretests, base-line measurements, and other safeguards against spurious results; few discussions of intervening or confounding variables . . . ; little attention to possibility of bias in recording and coding responses; and inadequate and inappropriate statistical analyses.

Many of these problems may not have occurred if the researchers had had more research preparation and experience for the quality and quantity of nursing research depends on the ability, preparation and research commitment of nursing researchers. Clearly, there must be more nurses prepared at the master's and doctoral level. As Wells (1979, p. 194) states

> Nursing education and practice rest on research; gerontological nursing will be encumbered until doctoral preparation in the field is given priority.

It is essential that the problems mentioned above be resolved if gerontological nursing research is to advance; that is the most pressing research need. There are, however, specific areas within gerontological nursing practice which call for study. The following are some of the areas which need to be investigated:

- The levels of rehabilitation for the elderly.
- The contribution of exercise in preventing degeneration--physical, mental and social.
- The contribution of exercise to rehabilitate the elderly.
- Development of health assessment tools capable of measuring possible levels of rehabilitation.
- Alternative systems of care for the elderly. Investigators should evaluate cost, compare the quality of care of different modes and their ability to prevent deterioration of functional and mental abilities.
- Variables that have an impact on entry into the health care system.
- The genesis of depression among the elderly.
- Physiological changes as they relate to nursing care functions (i.e., temperature taking, blood pressure, topical applications of heat and cold).
- The genesis of cryptogenic falls in the elderly.
- Factors that contribute to social interaction and social isolation among the elderly.
- Support systems that help in keeping the elderly independent.
- "Normal" aging versus pathological aging.
- Life-long habits and practices that impact on mental, physical and social deterioration of the aged.
- Differences in aging patterns between men and women and between various socioeconomic classes.

- -- Sleep disturbances among the elderly.
- -- Research on brain disorders among the elderly--in particular, senile dementia of the Alzheimer's disease type--to discover the clinical; biomedical and social aspects of the disorder.
- -- Development of health assessment measures which take into account the effect of aging (i.e., heart attack may occur in the elderly without chest pains; appendicitis may occur without tenderness).
- -- Interventions with the confused elderly.
- -- Methods which modify negative attitudes in health care personnel.
- -- Effects of instruction in relaxation techniques for individuals at risk for hypertension.
- -- Development of measurable indicators of wellness and well-being in adults.
- -- Effects of active and passive exercise routines on mobility status and alertness levels of nursing home residents.

There are other areas which also need investigating (see Appendix H for recommendations from Faye Abdellah, Assistant Surgeon General, and from the 1979 ANA Clinical and Scientific Sessions) and those areas listed are not meant to suggest priorities for gerontological nursing research.

The Need for Gerontological Nurses

The growing numbers of elderly and the shortage of practicing nurses are well known. That the health care needs of the elderly are diverse and complex is accepted by most health care professionals. The issue of who should provide the care needed by the elderly, particularly the institutionalized elderly, is far from resolved.

Care of the elderly involves more than just meeting their physical needs in a humane way. As was recently stated in a report from the Committee on Skilled Nursing Care (ANA, 1975, p. 15)

> The difference between professional and non-professional nursing care is often the difference between therapeutic and custodial care.
>
> To illustrate, a resident with loss of bowel and bladder control needs to be kept clean and dry. This is custodial care. There is no such thing as a custodial patient, only custodial care. Understanding why control has been lost, planning a training program with the resident and staff, understanding the feelings of both the resident and staff in coping with the unpleasantness is therapeutic nursing care. The registered nurse is responsible for the quality of nursing care in the facility regardless of who gives that care.

Although there is a paucity of research on the impact of skilled professional nursing care, what has been done suggests that professional nursing makes a difference in the functioning of the elderly. Thomas (1967) found that individualized nursing care of senile patients resulted in significant improvement in self care and senile status. Weis (1968) reported the results of an investigation of the impact of skilled nursing on the psychosocial behavior of elderly chronically ill patients in three nursing homes. Those who received skilled professional nursing care interacted more, spent more time in interaction and interpersonal activity (listening as well as talking), and had more frequent inter-patient communication. Introduction of skilled nursing care had greatest impact in more deprived settings although this intervention was effective in all settings. The investigators concluded that skilled nursing care had an appreciable effect on enhancing the psychosocial development and arresting psychosocial atrophy of older patients. These studies suggest that, at least for the institutionalized elderly, care provided by skilled professional nurses can--and does--make a difference.

There are two other agencies/settings which provide nursing for the elderly: the acute care hospital and the community health agency. The literature is virtually silent on the special care requirements of elderly persons utilizing these agencies even though more elderly will come in contact with these health care institutions than nursing homes.

Figures are available on the elderly's use of both acute care hospitals and community health agencies. In 1975, 17.4% of the elderly were hospitalized at least once as compared to 10.6% of the total population (Robb, 1980). At any given time the elderly comprise between 20 and 40% of the patient population in acute care hospitals. The average number of days per discharge for the elderly was 11.6. These figures show a slight increase since 1971 in the percentage of elderly hospitalized (16.1%) and a decrease in the average number of days per discharge (13.6).

In 1973 the National League for Nursing's Council of Home Health Agencies and Community Health Services studies the users of community health agency services. As might have been predicted, the services were given predominantly to the elderly. The median age of the community health agency user was 69 years with median length of service for the elderly being 38 days (Levenson, 1975). This same study reported that 63% of the discharges were to patients 65 or over. Brower (1979) estimated that community health nurses spend 85 - 95% of their time with elderly clients. Other sources have suggested that a small protion of the elderly (3%) utilize 70% of the community/home care services.

At a recent meeting of the American Public Health Association, Dorothy P. Rice, Director of the National Center for Health Statistics, made some projections for the utilization of services (Rice, 1978, pp. 12-13). She stated that, assuming current patterns of use prevail, by the year 2003

> Total days [of hospital care] would increase by 36 to 49 percent, with 11 to 20 percent of the increase due to aging of the population. Days of care per 1,000 population will rise by 9 to 16 percent, from 1,255 in 1978 to 1,371 or 1,453 in the year 2003.
>
> Again assuming that current patterns of use prevail in the future, there will be very large increases in the number of nursing home residents. From 1.3 million in 1978, it is projected the number will increase by 57 percent to 2.1 million with constant mortality, and by 112 percent to 2.8 million if mortality rates continue to decline as in the past 10 years. The increases are particularly large among residents 85 years of age and older, 84 percent assuming constant mortality and 213 percent with declining mortality. The number of residents per 1,000 population will increase from 6 in 1978 to 8 or 10 in 2003, changes of 25 and 64 percent, respectively.

The staffing patterns in nursing homes was first brought to public attention by the Senate Subcommittee on Long-Term Care in 1972. That survey revealed that the registered nurse to aid ratio was 1:5 (56,235 registered nurses; approximately 280,000 aides). Data from the National Nursing Home Survey: 1977 Summary for the United States (DHEW, 1979) indicate the ratio is now approximately 1:6 (66,900 registered nurses; 424,900 aides). At the present time there are approximately 1,235,400 nursing home beds in this country which are staffed by 4.8 professional (registered) nurses, 6.1 licensed practical nurses, and 30.3 nurses' aides/orderlies per 100 beds. It should be noted that current Federal regulations require that each nursing home, regardless of its size, have one registered nurse on duty during the day shift, seven days a week.

Available Pool of Nurses

It is obvious that if, as was stated earlier, professional nursing does make a difference in the quality of care received by the elderly, additional professional nurses must be found to provide nursing for the elderly in acute care, community health, and nursing home settings if the quality of care is to be improved.

Currently there are 1,401,633 registered nurses in this country; it is estimated that 987,234 or almost 70% of these are practicing. According to the American Journal of Nursing ("Nurses in Profile", January, 1980) 61.4% of the practicing nurses are employed in acute care hospitals, 8.1% in nursing homes, and 7.9% in community health agencies. Just over four percent of these nurses possess master's or doctoral degrees, 17.5% have baccalaureates, 11.2% have associate degrees, and 67.0% are graduates of diploma schools of nursing.

In an earlier section, the gerontological nursing component of basic (entry level) nursing programs was discussed as was the numbers of gerontological nurses with post-RN and graduate level preparation. When one compares the obvious need for additional professional gerontological nurses with the available pool of nurses, it can be seen that the need far exceeds the supply. Adding to the problem is the fact that until very recently the gerontological component of basic nursing programs was either non-existent or extremely limited. Even now most programs incorporate gerontological principles into existing courses with students receiving varying amounts of instruction and clinical experience with the elderly. This is particularly important when one recalls that the vast majority of nurses practicing today are basing their practice on entry level preparation.

The disparity between the need and supply of gerontological nurses is an issue that affects the quality of the health care available to the elderly. As such, it deserves the attention of nursing's professional organizations, selected Federal agencies, nurse educators, and practicing nurses as well. I would like to suggest that nurse researchers, particularly gerontological nurse researchers, also direct their attention to possible ways of either reducing the disparity or increasing the knowledge of efficacious and efficient gerontological nursing practice. In addition, study must be directed toward discovering the most effective ways of utilizing the existing corps of gerontological nurses.

Though the task confronting us may seem overwhelming at times, I am convinced that if we can stimulate gerontological nursing research we can begin to move toward solutions to the problems facing those concerned about the health care of our older persons.

Summary and Recommendations

Because of the care orientation of nursing, the nurse is the health care professional uniquely qualified to assume responsibility for a large portion of the care provided to the elderly, many of whom have chronic conditions for which there is, at the present time, no cure. As Hector (1973, p. 61) says

> There may be a time when a doctor feels there is nothing more that he can do for a patient, but the nurse never reaches this point, and up to the hour of death can always give care. It is this deep involvement in health and sickness in the community, continuing through time, that the nurse would see as her unique function, . . .

As an emerging profession, entry level education is still in a fluid state but the direction nursing is taking is toward more academic preparation with emphasis on graduate training for nursing specialties. This is shown in gerontological nursing by the present move away from certificate programs toward graduate (master's) programs.

Nurses have always had the option of undertaking doctoral preparation in disciplines other than nursing, an option which was exercized by many. However, the development of doctoral programs in nursing is further evidence of the profession's concern for academic preparation. Because many of these doctoral programs are new and consequently small, nurses will continue to obtain their doctorates outside of nursing, However, increasing numbers will be granted doctorates in nursing.

The most recent American Nurses' Association (1980) survey revealed that there are now at least 2,348 nurses with doctorates. Although this number is small, especially in comparison with the total number of nurses and the number of nursing programs, it does represent an increase of almost 500 from the number reported in the previous survey completed in 1972.

Of these 2,348, 8 indicated their major area to be gerontology; another 8 had gerontological nursing as their major; and 81, nursing research. The doctorally prepared nurses also were asked to indicate their area(s) of current research or academic activities. Seven percent of them indicated involvement in three areas directly related to the older adult--gerontology, aging and long-term care. It cannot be said that at the present time there is an existing cadre of gerontological nurse researchers but there is a nucleus of such a group with the potential of building upon and adding to the research-based knowledge of gerontological nursing.

Nursing research concerned with the older adult has increased markedly in the last fifteen years but many of these studies were small and rarely have they been replicated. In addition, the vast majority of the studies which have been done have focused on institutionalized elderly although this group represents only 5% of the aged population. Very few studies have been directed toward the non-ill elderly, aged individuals in the community and elderly patients in acute care settings.

The actual contribution of nursing to the care of the elderly has been great; its potential contribution is even greater. Nursing now has a nucleus of research prepared persons who can guide the profession toward the actualization of this potential. Although there is much that nursing itself can do--and is doing--to increase the knowledge base upon which to build gerontological nursing practice, there are many ways in which federal agencies can greatly assist nursing in this crucial endeavor. More specifically, I would urge the National Institute on Aging to give thoughtful consideration to the following recommendations:

1. The creation of a Geriatric/Gerontological Nursing Academic Award to foster careers in gerontological nursing research and to facilitate the establishing of gerontological nursing curricula in schools of nursing. Support would be given to selected individuals to further their research and educational development with the expectation that these individuals would conduct, supervise and encourage gerontological nursing research and assist in the development of gerontological nursing curricula. Although nurses can apply for the National Research Service Award for Senior Fellows and the New Investigator Award, because of the broad scope of these awards, it cannot be assumed that they will stimulate research specific to aging and nursing care of the aged.

If we are to ensure excellence in the nursing care of the aged, it is imperative that gerontological nursing be viewed as a challenging, rewarding, and specialized field. One possible way to nuture this perception is to provide models for nursing personnel and nursing students: nurse scholars who are researching and studying the problems confronting gerontological nursing practice.

2. The creation of a gerontological nursing research center. The center should be attached to a school of nursing which offers a strong research oriented doctorate. The school of nursing, in turn, could be in a university which has a geriatric/gerontology center and/or a nationally recognized department of gerontology. A gerontological nursing research center in such a setting could draw upon the existing research facilities and expertise of the nursing school as well as the facilities and expertise of the parent institution.

The advantages of a Center over a research program project are that a Center would be more efficient and thus more cost-effective than a program, in a) administering multiple research projects; b) recruiting, maintaining and utilizing a subject pool; c) developing channels of communication with local care facilities (e.g., nursing homes, community health agencies) and eliciting their support/cooperation in specific research projects; and d) developing computer applications to the problem of systems of care. In addition, whereas program projects most frequently support the research of scientists already at an institution, a Center could draw its investigators from many locations thus creating a "critical mass" of gerontological nurse researchers. This would result in a greater exchange of ideas and information which should expedite the growth of gerontological nursing knowledge. A Center would also provide an excellent site for postdoctoral nurse fellows to receive further training and experience in gerontological nursing research while predoctoral students would continue to receive their training and experience through education and involvement in individual research projects or projects which are a part of a program grant.

3. The encouragement of intramural studies on the care of the aged at the Clinical Center at Bethesda. At the present time many of the patients receiving care at the Clinical Center are elderly. With very little additional cost, studies of the specialized care required by older persons in acute care settings could be accomplished. This recommendation might necessitate the admission to treatment of a few more older persons but the primary requirement would be that of funding one or two gerontological nurse researchers and providing the necessary support for their studies at the Clinical Center.

4. The development of an experimental nursing home. This facility, in some respects, would be similar to the Clinical Center; the principal difference would be that persons would be admitted to this home because of nursing (care-related) problems rather than medical (disease-related) problems. The experimental nursing home should remain small (not over 50 beds) and should be staffed, at least initially, with gerontological nurses and one or two gerontological nurse researchers. A facility of this type could be used to develop and test innovative systems of care and to determine how each system impacts on the elderly person's ability to cope with his environment. It could also be used to test different patterns of staffing.

Like the Clinical Center, patients would be drawn from across the nation and would receive care at no cost to themselves or their families. Cost of care would be partially covered through Medicare, Medicaid and other third party payments.

5. The development of an experimental nursing home without walls. This approach would focus on keeping the elderly in their own homes for as long as possible and bringing the needed services to them rather than they to the services. It would require an interdisciplinary approach to meet the needs of the elderly in a randomly selected but carefully defined neighborhood. It would necessitate surveying the needs of the elderly residing in the neighborhood, inventorying the existing services available, discovering alternative sources of support/services, and developing new services as required by the needs of the elderly.

The team, which would be interdisciplinary in composition (e.g., a primary care nurse practitioner with a geriatric/gerontological focus; a clinical specialist with a community health focus; a family practice physician with a gerontological focus; a pharmacist; and a social worker), would be responsible for coordinating the services required to allow the elderly to remain in their homes and/or to return to them as quickly as possible in the event that the person required care which could only be given in an institution.

6. Sponsorship of a national workshop on gerontological nursing research. A workshop would greatly facilitate the dissemination of gerontological nursing research findings and would also provide for the cross-fertilization of ideas which is so essential to the development of knowledge in a complex area. Included in the workshop, in addition to reports of completed studies, might be sessions on methodological approaches to the study of care of the elderly, recent developments in the measurement of variables of importance, as well as recent developments in data analysis.

Although the sponsorship of such a workshop might begin with the National Institute in Aging, the Division of Gerontological Nursing Practice of the American Nurses' Association of the ANA itself could be asked to sponsor future workshops.

7. Sponsorship of consensus conferences on problems confronting gerontological nurses and others who provide care to the elderly. Here, again, sponsorship could being with NIA and then be transferred to an appropriate nursing group.

Each conference, which would bring together experts in a given area from a variety of disciplines, could culminate in the publishing of a "state of the art" paper. Possible topics for the conferences might include such problems as decubitus ulcers, roaming, incontinence, and confusion.

8. Special awareness within review groups of studies that cut across disciplines. Sensitivity to this type of proposal is particularly important for gerontological nursing research. Because gerontological nursing views the elderly person holistically, most frequently gerontological nursing research will call for a cross-disciplinary approach to the question being addressed. Proposals may not be clearly identifiable as either basic aging or social behavior but may indeed encompass aspects of both. For example, one of my colleagues is studying menopausal hot flash. Her study includes self-report data gathered and quantified using instruments and techniques developed by behavioral scientists. However, it also involves the gathering and quantifying of precise physiological data. Other nursing studies might include, in addition to behavioral and physiological approaches, concepts from sociology, economics, and/or public affairs.

Studies which draw from several disciplines are not the same as studies done within those disciplines; the proposed methodology/design/data analysis may only resemble those of the discipline(s) from which they are drawn. The strength of these studies, indeed, may be the unique way in which they have combined these diverse elements to examine some of the complexities of the problem which they address.

9. Development of alternative models of delivery of care. Providing care to the elderly while still allowing the older adult to retain as much control as possible is a very complex problem. In many instances, the existing systems of care force the recipient to give up control (to become dependent) of many aspects of his life because he needs assistance in a very specific area. For example, if an older person has difficulty ambulating, he may find that he has been turned into a "wrinkled baby" (Gray Panther Maggie Kuhn's term). In order to get the assistance/care he needs, he may

no longer be able to control when or what he will eat, when he will sleep or bathe, or even when he will get up in the morning.

The need for gerontological nursing research to build the knowledge upon which to base gerontological nursing practice is great. With the assistance of various federal agencies, the support of nursing and its organizations, and the leadership of its doctorally prepared nurse researchers I am confident that the health care of the elderly can--and will--be improved.

Appendix A

Available Curricular Material in Gerontological/Geriatric Nursing

General

American Academy of Nursing. *Long-Term Care in Perspective: Past, Present, and Future Directions for Nursing*. Kansas City, Missouri: The American Nurses' Association, 1976.

American Nurses' Association. *Nursing and Long-Term Care: Toward Quality Care for the Aged*. Kansas City, Missouri: The American Nurses' Association, 1975.

American Nurses' Association. *Standards for Practice: Gerontological Nursing*. Kansas City, Missouri: The American Nurses' Association, 1976.

Master's Preparation/Post-RN Training

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Heppler, Jacqueline. "Gerontological Nurse Practitioner: Change Agents in the Health Care Delivery Systems for the Aged." Journal of Gerontological Nursing, 2:38-40, 1976.

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Basic Nursing Programs

Bahr, Sister Rose Therese and Lucille Gress. "Nursing of the Aging Adult in Contemporary Society: A Course Review" *Journal of Gerontological Nursing*, 3:13-20, 1977.

Brock, Anna M. "Improving Nursing Care for the Elderly: An Educational Task." *Journal of Gerontological Nursing*, 3:26-28, 1977.

Chamberland, Gerry, Betty Rawls, Carla Powell and Mary Jo Roberts. "Improving Students' Attitudes Toward Aging." *Journal of Gerontological Nursing*, 4:44-45, 1978.

Appendix A (continued)

Continuing Education

American Nurses' Association. *Guidelines for Short-term Continuing Education Programs Preparing the Geriatric Nurse Practitioner.* Kansas City, Missouri: American Nurses' Association, 1974.

Hedman, Lorraine L., Rozanne M.Thatcher, Nathanial Gruner, James Erixon. "Assessing Continuing Education Course Outcomes in Gerontological Nursing." *Journal of Gerontological Nursing*, 2:10-14, 1976.

Zerbe, Melissa and Tom Hickey. "Self-Maintenance Skills: A Continuing Education Program for Geriatric Nursing." *Journal of Gerontological Nursing*, 1:5-11, 1975.

Appendix B

Programs that Award A Gerontological/Geriatric Nurse Practitioner Certificate*

University of California at Davis
Department of Family Practice

University of Colorado
School of Nursing

University of Miami
School of Nursing

Emory University
Nel Hodgson Woodruff School of Nursing

University of Kansas
School of Nursing

Cornell University-New York Hospital
School of Nursing

State University of New York
Upstate Medical Center

University of Pittsburgh
School of Nursing

University of Wisconsin-Madison
School of Nursing

*Excludes Adult and Family Nurse Practitioner Programs, either of which might have a gerontological thrust.

Source: Directory of Expanded Role Programs for Registered Nurses, 1979.

Appendix C

Programs That Award A Master's Degree Gerontological Component

University of Arizona
Tucson, Arizona

California State University, Long Beach
Long Beach, California

University of California, David
Davis, California

University of California, Los Angeles
Los Angeles, California

University of California, San Francisco
San Francisco, California

University of Delaware
Newark, Delaware

Rush University
Chicago, Illinois

University of Kansas
Kansas City, Kansas

University of Kentucky
Lexington, Kentucky

Boston University
Boston, Massachusetts

University of Maryland
Baltimore, Maryland

Adelphi University
Garden City, New York

Columbia University
New York, New York

University of Rochester
Rochester, New York

Duke University
Durham, North Carolina

Case Western Reserve University
Cleveland, Ohio

University of Cincinnati
Cincinnati, Ohio

The Pennsylvania State University
University Park, Pennsylvania

University of Pennsylvania
Philadelphia, Pennsylvania

Vanderbilt University
Nashville, Tennessee

University of Utah
Salt Lake City, Utah

Marquette University
Milwaukee, Wisconsin

University of Wisconsin-Milwaukee
Milwaukee, Wisconsin

Source: Sr. Erica Bunke, Program Coordinator, Division of Gerontological Nursing, The American Nurses' Association, 1980.

Appendix D

Doctoral Programs in Nursing

University of Alabama
Birmingham, Alabama 35294

University of Arizona[1]
Tucson, Arizona 85721

University of California[1]
San Francisco, California 94122

University of Colorado
Denver, Colorado 80262

The Catholic University of America[2]
Washington, D. C. 20017

University of Illinois[2]
Chicago, Illinois 60612

Rush University[1]
Chicago, Illinois 60612

Indiana University
Indianapolis, Indiana 46202

University of Maryland[1]
Baltimore, Maryland 21201

Boston University
Boston, Massachusetts 02115

University of Michigan[2]
Ann Arbor, Michigan 48104

Wayne State University
Detroit, Michigan 48202

Teachers College, Columbia University[1]
New York, New York 10027

New York University
New York, New York 10003

University of Rochester[1]
Rochester, New York 14642

Case Western Reserve University[1,2]
Cleveland, Ohio 44106

University of Pittsburgh
Pittsburgh, Pennsylvania 15261

University of Pennsylvania[1]
Philadelphia, Pennsylvania 19104

University of Texas
Austin, Texas 78712

Texas Women's University
Denton, Texas 76201

University of Utah[1]
Salt Lake City, Utah 84112

University of Washington
Seattle, Washington 98195

University of Wisconsin[2]
Madison, Wisconsin 53706
(to admit students Fall, 1980)

[1] Schools which also offer a Master's degree with a gerontological component.

[2] Schools which report a gerontological nursing emphasis in their doctoral program.

Appendix E

Selected Major Areas of Study of Doctorally Prepared Nurses

Area	Number
Adult Health Nursing	4
Community Health Nursing	16
Gerontological Nursing	8
Health Education	23
Health Planning	3
Health Science	1
Maternal-Child Health	5
Maternal-Child Health Nursing	36
Medical-Surgical Nursing	35
Nursing	91
Nursing Administration	31
Nursing Education	143
Nursing Research	81
Psychiatric-Mental Health Nursing	87
Public Health	34
Public Health Administration	29
Total	627
	(26.7% of total)

Source: Directory of Nurses with Doctoral Degrees, 1980. (ANA, 1980)

Appendix F

Gerontological Nursing Research Studies
Funded by the Division of Nursing
1957-1979

Investigator	Title	Dates
Brown, Martha M.	Nurse-Patient Relationships with Older Patients	April 1957 - March 1958
Brown, Martha M.	The Personalization of Older Patients	December 1957 - March 1962
Schwartz, Doris	Nursing Needs of Elderly Chronically Ill Ambulatory Patients	June 1958 - August 1964
Kelleher, Rita P.	Fact Finding Survey of Massachusetts Nursing Homes	May 1961 - May 1963
Putnam, Phyllis A.	Nurse Awareness and Psychosocial Function in the Aged	January 1972 - December 1972
Schultz, Phyllis R.	Primary Health Care to the Elderly: An Evaluation of Two Health Manpower Patterns	June 1974 - May 1977
Baltes, Margaret M.	Living Skills in the Elderly Nursing Home Resident	September 1977 - August 1979
Sheridan, John E.	Measures of Job Performance in Nursing Homes	July 1977 - December 1979
Sullivan, Judith A.	Health Maintenance Strategies for the Well Elderly	July 1978 - December 1980
Brower, H. Terri	Organizational Context of Nurses Attitudes Toward Aged	September 1978 - September 1979

Appendix G

Bibliography of Seclected Gerontological Nursing Text Books

American Academy of Nursing. Long-Term Care in Perspective: Past, Present, and Future Directions for Nursing. Kansas City, Missouri: The American Nurses' Association, 1976.

American Nurses' Association. Nursing and Long-Term Care: Toward Quality Care for the Aged. Kansas City, Missouri: The American Nurses' Association, 1975.

American Nurses' Association. Standards for Practice: Gerontological Nursing. Kansas City, Missouri: The American Nurses' Association, 1976.

Breitung, J. The Geriatric Care Manual: Processes and Procedures of Nurses, Health Assistants, and Home Health Aides. New York: Tiresias Press, Inc., 1980.

Brickner, Phillip W. Home Health Care for the Aged: How to Help Older People Stay in Their Own Homes and Out of Institutions. New York: Appleton-Century-Crofts, 1978.

Burnside, Irene. (Ed.) Nursing and the Aged. New York: McGraw-Hill, 1976.

Buseck, Sally and Eldonna M. Shields. The Gerontological Nursing Series. New York: American Journal of Nursing Company, 1980.

Carnevali, Doris and Maxine Patrick. Nursing Management for the Elderly. Philadelphia: Lippincott, 1979.

Futrel, May, Stephen Brovender, Elizabeth McKinnon-Mullet and H. Terri Brower. Primary Health Care of the Older Adult. North Scituate, MA: Duxbury Press, 1980.

Gunter, L. and C. Estes. Education for Gerontic Nursing. New York: Springer Publishing Co., 1979.

Leininger, Madeleine M. (Ed.) Transcultural Nursing 1979. New York: Masson, 1979.

Murray, Ruth Beckman and Judith P. Zanter. Nursing Assessment and Health Promotion Through the Life Span. 2nd Edition. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

Appendix G (continued)

Reinhardt, A. M. and M. D. Quinn (Eds.) Current Practice in Gerontological Nursing, Vol. I, St. Louis: C. V. Mosby Co., 1979.

Stillwell, Edna M. (Ed.) Readings in Gerontological Nursing. Thorofare, N.J.: Charles B. Slack, Inc., 1980.

Yurick, Ann G., Susanne S. Robb, Barbara E. Spier and Nancy J. Ebert. The Aged Person and the Nursing Process. New York: Appleton-Century-Crofts, 1980.

Appendix H

Recommendations for Research

The following recommendations were developed by Faye Abdellah, Assistant Surgeon General, Public Health Service.

CLINICAL

Treatment of skin lesions (decubitus ulcers; skin cancer).

Biofeedback in relation to treating medical problems of the elderly (behavior modification and reality orientation).

Identification of outcome measures of nursing practices that are both physiological and psychological.

Description of behavior patterns of patients with different types of diagnoses in different settings, e.g., Alzheimer's disease and dementias of aging; cerebral arteriosclerosis; arthritis, diabetes; homonomous hemianopsia in patients with cerebrovascular disorders.

Study of age-related deficiencies in gastrointestinal function, e.g., malabsorption patterns of the elderly.

Study and implications for nursing practice of normality of aging.

Care of the terminally ill (hospice care) and at-home care.

SOCIAL AND BEHAVIORAL

Study of the problems of stereotyping of the elderly; derogatory cartoons and jokes, perceptions of children about the old.

Role of family structure and supports with emphasis upon ways to prevent isolation, deprivation and loneliness.

Sociological and economic studies related to the process of aging.

Mental health aspects such as nursing intervention in depression, psychosis, drug and alcohol abuse, crisis situations, attempted suicide, relocation trauma.

REHABILITATION

Rehabilitation aspects, including use and care of prostheses (limbs, hearing aids, dentures, etc.).

DRUG THERAPY

Hazards of drug use, over and under medicating.

Psychophysiological absorption patterns in the elderly.

NUTRITION

Nutrition and the aging process.

EDUCATION AND TRAINING

There is a need for information about the educational preparation of gerontological nurse practitioners, family nurse practitioners, adult nurse practitioners, and primary care nurses (numbers, level and scope of knowledge, placement, setting, etc.).

The following group of suggestions for nursing research are from the ANA Clinical and Scientific Sessions (November, 1979).

I. Research Topics Identified by Conference Participants

   A. Priorities by Rank Order for Nursing Research

      1. Normative standards of aging - all subcategories
      2. Impact of government regulations on older adults
      3. Effect of nursing actions (autonomous) on older adults
      4. Theories of aging - specifically nursing theories
      5. Continuity of care - problems, gaps
      6. Motivation of nurses who practice gerontological nursing

Appendix H (continued)

B. Listing of Range of Topics of Nursing Research

1. Autonomous nursing actions
2. Norms of aging
    a. Tools
    b. Parameters
    c. Physiological
    d. Nutrition
    e. Sleep patterns
    f. Self concept (inadequacy of status)
3. Needs of rural population and accessibility of resources
4. Motivation of gerontological nurses
5. Effect of government regulations on older adults
6. Theories of aging - development of nursing theories
7. Continuity of care
8. Supports for families caring for older adults
9. Alternative approaches to care of older family members at home
10. Complexity of adaptation process (Roy's Adaptation Theory)
11. Long-term care regulations
12. Documentation process (recordkeeping)
13. Risk taking by nurses
14. Use of restraints (physical)
15. Medications (interactions)
16. Physician-patient (relationships)
17. Family expectations of older members, care giving staff
18. Activity theory
19. Disengagement theory

Learning and Memory
Through Adulthood

Marion Perlmutter
Institute of Child Development
University of Minnesota

To appear in: Riley, M. W. Leading Edges: Recent Developments in Social and Psychological Aging. Bethesda, Maryland: National Institute of Aging Publication.

Running Head:

| MP801A |

Learning and Memory Through Adulthood

Considerable research attention has been devoted to demonstrating, and elucidating the nature of, age-related changes in adult learning and memory. The impetus for this extensive concern with learning and memory has come from both experimental psychologists, who traditionally have focused on these topics, and clinical psychologists, who often are faced with complaints about failing memory of older adults. In general, the research has been framed within the theoretical models dominant in experimental psychology, that is, associationism in the 50s and 60s, and information processing in the 70s and 80s. In addition, however, several unique issues have emerged from the clinical perspective.

Conceptually, learning and memory may be distinguished. For example, learning might be defined as the _acquisition_ of information or skill that has resulted from experience, and remembering might be defined as the _retrieval_ of information or skill that has been learned previously. Experimentally, however, it is difficult, if not impossible, for learning and memory to be separated. That is, in order for subjects to demonstrate learning they must have memory, and in order for memory to be demonstrated learning must have occurred. Thus, for the purposes of this paper, learning and memory will considered together.

The paper contains a review of research on learning and memory throughout adulthood. First, experimental research is considered. The general theoretical and methodological perspective that has guided most recent experimental research is summarized, and empirical evidence of age-related differences in learning and memory that has come from laboratory studies is presented. Then, real world learning and memory are considered. In particular, evidence of adulthood acquisition and retention of physical, cognitive, and social information and skills is presented. Several conclusions are then drawn from the reviewed research. In particular, attention is given to the functional significance and practical implications of the findings, and limitations of past emphasis and suggestions for future directions are provided. Finally, some of the factors that may contribute to cognitive aging are considered, and analyzed in terms of the changing socio-economic milieu.

I. Experimental Evidence of Age Differences in Adult Learning and Memory

Information Processing Model and Experimental Methodology

During the last decade or two, information processing models have dominated experimental psychology and its research on learning and memory. Very briefly, learning and memory are viewed as time based processes that transfer information within a multi-store or multi-level cognitive system. Information is learned or acquired, stored, and retrieved or remembered, from sensory, primary, and secondary stores.

An important assumption of this perspective is that subjects participate actively in learning and remembering. Indeed, for the information processing researcher, the cognitive activities that are used in learning and remembering are the central phenomena to be investigated, and possible age differences in these activities are the focus of developmental research. | A3 |

In general, cross-sectional designs have been used to assess whether there are developmental differences in learning and memory skills. Most typically performance of college students has been compared with that of adults in their sixties. Experimental sessions have consisted of testing subjects on tasks designed to illuminate cognitive processing. In this manner experimenters have made inferences about age differences in learning and memory. Moreover, by manipulating particular variables, under highly controlled conditions, experimenters have been able to determine whether the constraints on learning and memory vary across age. Differential age patterns under various conditions often have been informative for elucidating the nature of age differences.

Empirical Evidence

Conditioning. Conditioning often is viewed as the simplest form of learning. In classical conditioning an organism learns to make a generalized response to a signal, and in operant conditioning an organism acquires an instrumental response to a discriminated stimulus.

Prior to 1960 there was considerable interest in human conditioning. However, in recent years there have been very few human aging studies of conditioning. Still, there are some important issues to be resolved within the classical conditioning paradigm. For example, in two studies of classical conditioning of the eyeblink response Braun and Geiselhart (1959) and Kimble and Pennypacker (1963) found that older adults had greater difficulty acquiring a conditioned eyeblink response than did younger adults. Moreover, Kimble and Pennypacker (1963) found that the magnitude of the unconditioned response was significantly correlated with the frequency of conditioned responses. Thus, it was hypothesized that over time, the eyeblink response becomes habituated or partially adapted out, and therefore is less susceptible to modification by conditioning procedures. In order to draw firm conclusions about possible age differences in susceptibility to classical conditioning, additional research, involving different responses, is needed. The evidence that is available (e.g., Shmavonian, Miller, & Cohen, 1968, 1970) seems to indicate that on a variety of autonomic measures there are weaker conditioned and unconditioned responses in older than younger adults. | A4 |

There are other factors that probably contribute to age differences in classical conditioning as well. For example, the strength of the conditioned and unconditioned stimuli are known to have important influences on conditioning, and are likely to differ across age, since older adults' sensory functioning typically is to be reduced. The time parameters chosen in particular experiments might also contribute to conclusions about age related differences in conditioning, since older adults generally require longer time to encode and respond to stimuli than do younger adults.

Operant conditioning also has received scant experimental attention in recent research on human aging, although these techniques have begun to get considerably use in a variety of applied settings. Moreover, the research that is available points to the efficacy of reinforcement procedures, even for adults well into their seventies (e.g., Ayllon & Azrin, 1965; Baltes & Zerbe, 1976). Thus, even though all of the parameters of operant conditioning have not yet been documented for older adults, it already is clear that these procedures can be effective controllers of behavior in later life. It should be noted, however, that reinforcers that are optimally effective for the young probably are not always the same as those that are most effective for the elderly.

Sensory Memory. The most immediate form of memory, sensory memory, involves retention of information for very short amounts of time, that is, for less than a second. While age differences in sensory memory have been examined in relatively few studies, it generally is assumed that if sensory registration occurs, learning and cognitive difficulties of the elderly lie deeper in the system, rather than in peripheral stages (e.g., Craik, 1976; Walsh & Prasse, 1980). | A5 |

Still, it should be noted that older adults experience sensory deficits (see Kimmel, 1974), and these deficits may be relevant to learning and memory. That is, since higher thresholds of stimulation are required for older subjects to sense and perceive information, some apparent learning and memory deficits may be more appropriately attributed to failures in sensory registration.

Additionally, it should be noted that age-related difficulties in dealing with situations requiring division of attention may contribute to learning and memory deficits (e.g., Craik & Simon, 1980; Kinsbourne, 1980). It is well documented that older adults are more penalized than younger adults when they must jointly attend to two input sources, an input source and memory, or memory and response execution (see Kay, 1953). In a series of divided attention studies Craik (1973) concluded that much of older adults' processing capacity is taken up by organizing or programming division of attention, and this leaves less capacity for processing information. If older adults' capacity is reduced in this way, they may be forced to process information less deeply, and this difference in processing may account for memory deficits.

Primary Memory. Memory involves representation of the present, as well as knowledge about the past. Memory investigators generally speak of primary memory when referring to the first, that is, the number of items retained in consciousness, and of secondary memory when referring to the second, that is, more permanent knowledge (e.g., Waugh & Norman, 1965). There are at least three reasons for making this conceptual distinction. First, these memory stages have different functions; while primary memory temporarily holds or organizes information, secondary memory is a permanent knowledge store. Second, some processes, for example retrieval, probably are more central to secondary than primary memory. Finally, the course of development of these two sorts of memory may be different. For instance, it appears that primary memory is relatively unimpaired in the elderly, but that there are age decrements in secondary memory. | A6 |

One measure of primary memory is the recency portion of free recall, that is, retention of the last few items on a recall list. In most experiments no age differences in the recency portion of recall have been demonstrated. That is, even when age differences are observed in overall level of recall, no age differences are found for the last few serial items (e.g., Bromely, 1958; Craik, 1968).

Another procedure used to evaluate primary memory is the memory span task. This task involves determining the number of items in the longest string that can be reported in correct serial order. While most people can recall approximately seven digits or five words in correct serial order, other estimates of primary memory range from two to four items (See Watkins, 1974). Thus, memory span probably reflects some information from secondary memory as well as the information in primary memory. Many investigators find no significant age differences in digit spans of 20 to 65 year olds (e.g., Bromely, 1958; Craik, 1968), and some report slight but reliable age decrements (e.g., Botwinick & Storandt, 1974; Taub, 1973).

A similar task, backward span, requires subjects to repeat strings of items, but in reverse order. Generally, larger age deficits are found on backward, than forward span tasks (e.g., Botwinick & Storandt, 1974; Bromely, 1958). Apparently, if reorganization is added to the retention requirement, older subjects become more disadvantaged. It appears that older subjects' performance is unimpaired when only primary memory is tapped, but deficits are observed when additional cognitive activity, such as organization, is required.

Of course, in these studies performance is measured by number of items recalled, and that measure may not be the most sensitive index of mnemonic functioning. Anders, Fozard, and Lillyquist (1972) used the Sternberg (1966) reaction time paradigm to assess age differences in primary memory more precisely. Subjects were presented sequences of one to seven items, and then required to decide whether a test item had appeared on the list. The dependent measure of interest was time required to make decisions for items from various length lists. For all age groups (20-, 38-, and 68-year-olds) decision latencies increased linearly with list length. However, changes in the slopes of these functions suggested that search speed decreased with age. Furthermore, since the intercepts of the latency functions increased with age, there probably also was an age related slowing of other basic operations, such as decision or response execution. Thus, although the number of items retrieved from primary memory may remain essentially stable throughout adulthood, the speed of search and retrieval probably declines.

Secondary Memory. Remembering more items than can be held in primary memory is indicative of secondary memory. It is important to note that this primary-secondary memory distinction is independent of retention interval. That is, even when retention is tested immediately, if primary memory span has been exceeded, secondary memory contributes to performance. Furthermore, it apparently is the secondary memory system that is most impaired by aging (e.g., Craik, 1976; Horn, 1976). | A8 |

Indeed there has been much research concerned with the nature of age differences in learning and memory of this more permanent sort. In most of the research verbal stimuli have been used. Investigators have been interested in whether there are age differences in learning and retention of lists of words, and whether the magnitude of age differences are affected by specific variables.

The overwhelming evidence points to age differences in learning and memory in the secondary store; groups of older adults (60s) typically perform statistically worse than groups of younger adults (20s). It should be noted, however, that even the performance of the oldest subjects almost always is well above chance level, and the distributions of performance of the different age groups almost always overlap. Moreover, the pattern of age differences observed under various experimental conditions differs; several manipulations have been found to attenuate age differences. Indeed, the differing patterns of performance under various experimental conditions point to performance factors that contribute to age differences, and leaves open to question the extent to which there are age differences in learning and memory ability per se (see Agrusa, 1978; Arenberg & Robertson-Tchabo, 1977; Botwinick, 1978; Poon, Fozard, Cermak, Arenberg, & Thompson, 1980). | A9 [

For example, age differences in motivation have been hypothesized to contribute to the often observed age-related decrements on secondary learning and memory tasks. Typically, it has been assumed that older adults are not as motivated as younger adults to perform well in laboratory situations where there is little that is meaningful to them. However, Botwinick (1978) has argued that older adults actually are more involved in experimental situations than are younger adults, and in fact, that they are sometimes inappropriately involved, to an extent that depresses their performance. Evidence for this view comes from psychophysiological studies of arousal state, indicating that older adults often are overly aroused during experimental sessions (e.g., Furchgott & Busemeyer, 1976; Powell, Eisdorfer, & Bogdonoff, 1964). Moreover, when these arousal states have been reduced by drugs, or adaptation to the laboratory situation, performance has been found to improve (e.g., Eisdorfer, 1968;

Eisdorfer, Nowlin, & Wilkie, 1970).

Older adults also are thought to be more cautious than younger adults. This tendency toward cautiousness often makes them appear to have learned and remembered less than they actually have. Evidence for this view comes from a fairly consistent finding that older adults make many errors of omission, but rarely errors of incorrect responding (e.g., Eisdorfer, Axelrod, & Wilkie, 1963; Korchin & Basowitz, 1957). Moreover, in one study in which omission errors were discouraged by rewarding all responses, regardless of whether they were correct or incorrect, older adults' learning performance improved more than younger adults (Leech & Witte, 1971). | A10 |

Another hypothesized explanation of age-related deficits in secondary learning and memory performance is that older adults are more prone to interference effects than are younger adults. Unfortunately, as noted by Arenberg and Robertson-Tchabo (1977), methodological difficulties presently make it impossible to evaluate this hypothesis.

One factor that has been clearly demonstrated to contribute to age differences in secondary learning and memory performance is pacing. There have been a number of studies in which amount of time stimuli are available for study and/or amount of time available for response are varied. In general, it has been found that older adults are especially disadvantaged when time is limited, and that this effect is particularly strong when there are limitations in response time (e.g., Arenberg, 1965; Canestrari, 1963; Eisdorfer, Axelrod, & Wilkies, 1963; Monge & Hultsch, 1971; Taub, 1967). Thus, when sufficient time for response is available performance of older adults is only slightly worse than that of younger adults. This finding indicates that older adults need more time than younger adults to show what they have learned and remembered.

However, even when given a long time for response older adults perform relatively poorly if they have been rushed during study. Thus, it appears that older adults also need more time to learn material than do younger adults.

Older adults' need for extra learning and response time may be related to limitations in their spontaneous use of effective cognitive processes. Since secondary memory is assumed to involve three major stages of processing (acquisition, storage, and retrieval), much research has been devoted to isolating the stage at which processing may be limited. While it is impossible to totally isolate a single stage of processing certain experimental manipulations permit investigators to gain some estimate of acquisitional and retrieval processing deficits. | A11 |

If age deficits in secondary memory are primarily attributable to deficiencies in acquisitional processing, then age difference should not be observed when initial learning has been equated. In several studies this finding has been obtained (e.g., Moenster, 1972; Hulicka & Weiss, 1965; Wimer & Wigdor, 1958). The study carried out by Hulicka and Weiss (1965) can serve as an example. They had subjects learn paired associates under three conditions: equal number of training trials, learning to criterion, and overlearning. Older subjects learned less with equal exposures and required more trials to criterion, but once having learned the material they retained it as well as younger subjects. At least in paired-associate tasks, age deficits in retention apparently can be eliminated by providing older subjects with extra exposure to the stimulus materials.

The results of these paired-associate learning studies, however, do not explain why older adults require additional exposure. Several theorists hypothesize various mechanisms to account for acquisition of superspan amounts of information. Miller (1956) suggested that items must be chunked, Mandler (1967) considered categorical organization important, Flavell (1970) argued for verbal rehearsal, Paivio (1971) emphasized imagery, and Craik and Lockhart (1972) proposed depth of processing as the major determinant. In several studies age differences in the use of these acquisitional mechanisms have been examined. | A12 |

Hulicka and Grossman (1967) investigated age differences in the use of verbal and imaginal mediators and their effect on recall. They compared younger (16-year-old) and older (74-year-old) subjects' paired-associate learning performance under a control and three mediational instruction conditions. In the control condition no special instructions were given, in a verbal instructions condition subjects were provided with a word or phrase that linked the words of the pair, in an experimenter image condition they were provided with a connector and told to form an image of the scene suggested by the phrase, and in a self image condition they simply were instructed to attempt to form an image that included both items of the pair. When no instructions were given younger subjects reported using mediators more than older subjects. Additionally, performance of all subjects inproved with mediational instructions, both when given only the technique and when given the mediators as well as the technique. Moreover, instructions improved older subjects' performance more than younger subjects'; the age effect was attenuated by mediational instructions. Apparently older subjects are able to perform mnemonic operations effectively, but typically fail to do so spontaneously.

These results were essentially confirmed by Canestrari (1968). He used a paired associate task, two age levels (20- and 62-year-olds), and three instructional conditions (standard, verbal mediators, and pictorial mediators). He found that younger subjects' performance was better than older subjects' regardless of condition, and mediators improved all subjects' performance. Moreover, providing mediators resulted in greater improvement for older subjects. | A13 |

Decreases in use of organization also may limit older subjects' memory. Clustering analyses may be used to assess the extent to which words from the same category are recalled together. Although this measure might simply reflect organization at retrieval, it generally also is considered to reflect organization imposed on incoming material. Denney (1974) examined recall and clustering of middle aged (42-year-olds) and elderly (81-year-olds) subjects on two stimulus lists. One list was composed of eight complementary related pairs of words and the other of eight similarly related pairs. Older subjects recalled fewer words, and clustered less than younger subjects. Additionally, while younger subjects clustered more on the similartly than complementary list, older subjects showed comparably non-significant levels of clustering on both lists. These results point to an age-related decline in use of organization, and this decline, at least in part, may account for memory decrements in the elderly.

Hultsch (1969) investigated age differences in organization and recall by manipulating instructions. He gave three age levels (17-, 35-, and 49-year-olds) a multitrial free recall task. A control group received standard free recall instructions, an organization instructions group was told to try to organize the lists in some way, and an alphabetic instructions group was told to try to organize the words alphabetically. The results indicated that both instructions to organize benefited older subjects disproportionately. This finding again suggests that there may be age-related deficits in organization. Apparently older subjects were not using organization spontaneously, although the evidence indicates that they could if instructed to, and that doing so improved their performance. | A14 |

In a subsequent study Hultsch (1971) utilized a free classification task that permitted more direct assessment of age differences in organization. His design included three age levels (24-, 46-, and 62-year-olds), and two experimental conditions (sorting and nonsorting). There were no significant decrements in recall. Additionally, the level of recall of all subjects was higher in the sorting than in the nonsorting condition, but there was a significant age by condition intereaction, indicating greater age decrements in the nonsorting than in the sorting conditions. Age differences were attenuated when subjects were encouraged to organize stimulus materials meaningfully. Thus, this study again indicates that at least a portion of the memory deficit observed in older adults can be attributed to their failure to effectively organize material at acquisition. Moreover, instructions and sorting manipulations are effective in reducing, although not eliminating, age differences. An organizational production deficiency apparently accounts for part of the memory impairment associated with aging.

If production deficiencies are a major source of age decrements, then equating acquisition by controlling a wide range of encoding operations should attenuate age differences in memory. In a number of studies the effects of such manipulations have been investigated. Indeed, it is quite informative to consider a group of experiments in which 1) depth or quality of encoding processing, 2) goal of encoding activity, and 3) retrieval support at testing, have been manipulated. | A15 |

When depth or quality of encoding processing is manipulated subjects are required to carry out different kinds of operations or decisions during presentation of stimuli. For example, subjects might be asked whether words rhyme or not, or if they have pleasant or unpleasant connotations. The latter task requires more meaningful analysis than the former, and typically leads to better memory performance. By comparing various age groups' memory performance following such controlled encoding conditions, investigators have made inferences about age differences in encoding abilities. Since subjects' processing is directed by the orienting tasks, it has been argued that performance differences can be attributed to subjects' ability to process in the required manner.

When goal of encoding activity is manipulated knowledge of forthcoming memory tests is varied. If memory tests are expected adults are assumed to activate mnemonic strategies that will facilitate retention. Thus, by comparing the difference of various age groups' memory performance following incidental versus intentional instructions, investigators have made inferences about age differences in the spontaneous use of encoding operations. That is, since subjects' processing is not specifically directed by intentional instructions, performance following such instructions is an index of spontaneous mnemonic processing.

Finally, when retrieval support in the testing environment is manipulated type of retention test is varied. For example, subjects might be given free recall, cued recall, or recognition tests. With cued recall tests subjects are provided with somewhat more retrieval support than with free recall tests and with recognition tests maximal retrieval support is provided. In general, increasing retrieval support has been found to increase memory performance. By comparing the relative benefits of added retrieval support to various age groups, investigators have made inferences about age differences in retrieval skills. To the degree that retrieval support differentially aids particular age groups' memory performance it has been argued that the subjects are deficient in the required retrieval skills. | A16 |

Table 1 summarizes twelve experiments in which at least some manipulations of depth of processing, goal of encoding activity, and retrieval support, were carried out with younger and older adults.

Insert Table 1 about here

A rather clear picture emerges from these fairly diverse experiments.

First, under standard intentional memory instructions statistically reliable age differences in free recall have been obtained in all relevant experiments, with these differences averaging 13% (range = 8% to 28%). Similarly, when orienting tasks have been paired with expectation of memory tests, age differences in free recall also averaged 13% (range = 2% to 15%), and were statistically significant in all but one instance (Mason, 1979, shallow orienting task). On the other hand, when memory tests have not been expected, age differences in free recall averaged only 5% (range = 0 to 17%), and were statistically significant in only 5 of 18 instances. This pattern of results suggests that encoding ability probably is less central to age differences in adult memory than is spontaneous use of optimal encoding operations. However, all of the results discussed thus far were obtained with free recall procedures. Additional support for this view emerges from the results obtained with recognition procedures, where retrieval demands are minimized. | A17 |

In recognition, under standard intentional memory instructions substantial age differences generally have been observed (mean = 9%, range = 5% to 40%); in five of seven experiments including this condition the age difference was statistically significant. Of the remaining two experiments, Erber's (1979) findings were likely to be limited by ceiling effects, and Mason (1979) reported only d' scores. While her d' means were higher for younger than older subjects, it is still unclear why the difference was not larger.

The recognition performance following orienting tasks also strongly implicates subjects spontaneous use of the efficient encoding operations available to them as a significant factor contributing to the memory advantage often observed for younger adults. When orienting tasks have been paired with expectation of memory tests, age differences in recognition averaged 12% (range = 0 to 26%), and were significant in all but the Erber (1979) and Mason (1979) studies. On the other hand, when memory tests have followed orienting tasks in which forthcoming memory tests have not been expected, age differences in recognition averaged only 5% (range = 0 to 9%), and were never statistically significant. Thus, when retrieval support has been provided, and encoding operations directed, age differences seem to vanish. Apparently encoding abilities of younger and older adults do not differ, although their spontaneous use of encoding operations do.

It should be noted that this conclusion suggests that intention to remember plays a much greater role in memory performance than the nondevelopment literature on memory would lead one to expect (e.g., Hyde & Jenkins, 1969; Johnston & Jenkins, 1971; Walsh & Jenkins, 1973). It appears that an understanding of memory based solely on fairly homogeneous samples of college students may lead to important misconceptions. | A18 |.

To reiterate the major points here, older adults' poorer performance on memory tests of word lists appears to be accounted for by their inefficient spontaneous use of encoding strategies. While other cognitive limitations may affect their memory performance on other tasks, list learning studies provide little evidence of deficits in older adults' encoding abilities. Nevertheless, evaluations of encoding that are based only on inferences from memory performance rely upon circular reasoning, and thus are inadequate. Therefore, additional means of assessing encoding independently of retention are required.

One such line of research on the independent assessment of encoding has utilized an associative orienting task (Perlmutter, 1979). Subjects were asked to generate free associations to the same words on each of four trials. The processing required to generate free associations was assumed to be somewhat similar to the processing used when trying to learn lists of words. Moreover, since this association task has been used as a semantic encoding condition in several studies of memory aging, directly assessing possible age differences in carrying out this task should be useful. The results indicated that older subjects produced somewhat less common associates than younger subjects. Perhaps of greater relevance to memory performance, however, was the finding that both the percentage of same associations generated over four trials, and the total number of different associations that were produced, indicated that younger adults were more consistent, and older adults a more variable, in associative productions. While these differences reached statistical significance, it should be noted that their magnitudes were quite small. | A19 |

In a second study (Perlmutter & Mitchell, unpublished data), carried out to replicate these findings, two additional conditions, designed to determine whether possible age differences in the consistency of spontaneous associative productions reflected capacity differences or simply dispositional differences, were included. Subjects either simply were told to generate the first association that came to mind (free condition), to try to generate the same association on each trial (same condition), or to try to generate a different association on each trial (different condition). In this study, younger subjects actually were less consistent than older subjects, although this difference was not statistically significant. Of further interest was the virtually identical performance of younger and older subjects in both the same and different conditions. Apparently, when so instructed, younger and older adults are equally competent at generating and monitoring their productions of either consistent or inconsistent associations. In general then, the results of these association studies are in agreement with the findings of the memory studies. It appears that when directed to carry out associative encoding younger and older adults' processing is quite similar.

Another nonmemory paradigm also has been employed to evaluate possible age differenes in encoding processes, independently of the retrieval requirements that can contribute to age differences in recall and even recognition. In particular, reaction time patterns have been examined. The use of reaction times as sensitive indices of on going processing has a long history in cognitive psychology. Across a wide variety of procedures (e.g., Stroop tasks, lexical decision tasks, picture naming tasks), it has been shown that the nature of the semantic relationship between two or more items can inhibit or facilitate reaction times systematically (e.g., Meyer & Schaneveldt, 1976). Such reaction time patterns are thought to reflect activation of semantic knowledge structures, and thus can provide an index of processing that is independent of episodic memory performance. Furthermore, even unattended stimuli have been shown to facilitate or inhibit response latencies to process target stimuli, depending upon their semantic relatedness to targets (cf. Shaffer & LaBerge, 1979). | A20 |

In one such study (Mitchell & Perlmutter, unpublished manuscript) reaction times were recorded as subjects made semantic (animate vs. inanimate) or nonsemantic (upper vs. lower case type) decisions about target words that were paired with distractors. These orienting tasks were followed by expected or unexpected tests of recall and recognition of both targets and distractors. To the extent that distractors influence reaction times they are assumed to have been processed. Thus, the reaction time data provided a relatively direct measure of processing during encoding. If, when engaged in the semantic orienting task, all subjects process information to a deep semantic level, parallel patterns of reaction times, reflecting the semantic relationshp between target and distractor stimuli, should be obtained for younger and older subjects. On the other hand, if, even when so directed, older adults do not engage in as deep level semantic processing (the processing deficit hypothesis), then their pattern of reaction times under the semantic orienting task should not reflect the semantic relationship between target and distractor stimuli, but should parallel their reaction times under the nonsemantic orienting task.

For both age groups distractors had little effect on reaction times in the nonsemantic task, but as predicted, reaction times varied as a function of target-distractor relationship in the semantic task. The fact that both age groups' performance was sensitive to the distractor type manipulation in the semantic task demonstrates that such reaction time paradigms may be useful for elucidating encoding processes across adulthood.

The memory data also were of interest. In general, these results point to remarkable similarities in younger and older subjects' processing as well, although some important differences emerged. Consider first performance when memory tests were unexpected. The semantic orienting task led to better retention than the nonsemantic orienting task, and target stimuli were remembered better than distractors. Of greater note, however, were the lack of age main effects or interactions involving age. When encoding processing was controlled by the rapid decision orienting tasks, and memory tests were not expected, there were no significant age differences in retention performance. Consider next performance when memory tests were expected. Overall performance was better with knowledge of forthcoming memory tests. However, this improvement was evident primarily following nonsemantic processing, and was observed only in younger subjects. Again, targets were remembered better than distractors. In addition, the semantic orienting task again led to better retention of targets than the nonsemantic orienting task; however, there was no such difference for distractors. Of greater note were the significant age main effects and age x item type interactions. When memory tests were expected younger subjects remembered more than older subjects, although this age trend was only statistically significant for distractors. This finding of an age difference in retention of distractors on expected memory tests seems to point to strategy and/or capacity advantages in younger adults. While the older subjects' performance on distractors did not change over trial blocks, the younger subjects' retention of distractors increased dramatically on the second trial block. Knowledge of forthcoming memory tests appears to have prodded the younger subjects to invoke strategies for encoding and retrieving irrelevant distractors. This finding indicates that the younger subjects were able to carry out supplemental processing, even while carrying out the orienting tasks. At this point it remains unclear whether the older subjects simply did not attempt to modify their processing in this way, or whether the processing demands of the orienting tasks left insufficient capacity to do so. Recent evidence suggests that deeper levels of processing require greater proportions of processing capacity (e.g., Eysenck & Eysenck, 1979), but the possibility that these processing demands change differentially across the lifespan has not been investigated empirically. Nevertheless, the finding of age differences only when memory tests were expected is consonant with several other studies in which larger age differences have been obtained for intentional relative to incidental memory (e.g., Erber, 1979; Perlmutter, 1978, 1979a). | A22 |

Thus far the prevalent type of research on age differences in secondary memory has been discussed, that is, research on retention of lists of words. In general, this research has demonstrated age-related deficits when subjects are left on their own, to study stimuli in whatever manner they choose. However, when subjects' study is directed in certain ways age differences often are ameliorated. These findings suggest that an important factor contributing to age differences in memory performance is change in effective strategy use. It appears that effective mnemonic processing is within the repertoire of older adults, although it is less likely to be employed by them.

Of course, this perspective has developed mainly from studies of deliberate retention. In recent theoretical statements about memory it has been suggested that automatic and effortful processing should be distinguished (Hasher & Zacks, 1979). In particular, it has been claimed that automatic and effortful operations vary in their attentional requirements. Automatic operations drain minimal energy from the limited-capacity attention mechanism and do not interfere with ongoing cognitive capacity. On the other hand, effortful operations require considerable capacity and interfere with other cognitive activities also requiring capacity. Automatic operations are expected to develop earlier in life and reach a level of maximal efficiency sooner than effortful processing mechanisms. Moreover, development across the life span is expected to have a greater impact on effortful than on automatic processes. The question remains, however, whether there are age-related deficits in retention of information presumed to be encoded automatically. | A23 |

Processes that encode the fundamental aspects of the flow of information, such as the frequency and recency of events, generally are considered to be automatic processes (Hasher & Zacks, 1979). It is assumed that storage of these types of informaton is an obligatory concomitant of normal encoding. That is, that such information is acquired without intention and thus is not susceptible to alteration by manipulations such as instructions to remember, practice, or feedback concerning accuracy of performance.

In a recent study (Perlmutter, Metzger, Nezworski, & Miller, 1981) younger and older adults were tested for their retention of the recency of occurrence of stimuli. Age accounted for less than 1% of the variance in performance, with both age groups performing between 60 and 65% correct. These findings are in agreement with the developmental invariance of automatic processing hypothesis. Similarly, Attig and Hasher (1980) and Kausler and Puckett (1980) found no age-related deficits in adults' retention of the frequency of occurrence of stimuli. These results would seem to add further support to the view that the major factor contributing to memory decline in later adulthood is decreasing effective strategy use. | A24 |

The above analysis probably is incorrect, however. In the studies just discussed age differences were not observed in retention of information presumed to be encoded automatically. Yet, it is not clear whether the required encoding interfered with other cognitive activities. For example, in another study carried out by Kausler and Puckett (1981) both incidental and intentional retention of the content and sex of voice of sentences was investigated. In both conditions only minor age differences between younger and older adults' retention of sex of voice were found. However, intentional encoding of this information significantly diminished older, but not younger, subjects' retention of sentence content. These results seem to point to an age-related decrement in total processing capacity. For older adults enchanced encoding of nonsemantic information occurred at the expense of encoding of semantic information. On the other hand, for younger adults the apparently larger capacity of their processing system resulted in virtually no trade-off or adverse effect of additional intentional encoding.

This apparent processing surplus in younger adults also seems to be a viable explanation of the one age difference observed in the rapid decision orienting task study discussed earlier (Mitchell & Perlmutter, unpublished manuscript). The only significant age difference observed in that study was for older subjects to retain fewer distractor items than younger subjects on expected memory tests. While, when expecting memory tests, younger subjects apparently had the required capacity to engage in supplemental encoding, that could increase their retention of irrelevant stimuli, such additional processing was not evident in older subjects. | A25 |

It is interesting too that such a processing surplus view of younger adults is consistent with a number of previously unexplained inconsistencies in levels of processing studies of memory aging. While in some laboratories, such as Craik's and Perlmutter's, it has been possible to eliminate age differences with semantic orienting tasks and recognition testing, in other laboratories, such as Smith's (see, e.g., Mason, 1979; Smith, 1980), this amelioration of age differences has not always been obtained. It appears that when orienting instructions have not been paired with expectation of memory tests age differences generally can be eliminated, but when orienting instructions have been paired with expectation of memory tests age differences persist. Indeed, in a single study Erber (1979) has compared younger and older adults' retention following nonsemantic and semantic orienting tasks that were administered either incidentally or intentionally. For both orienting tasks younger adults' performance was substantially better with the addition of intentional instructions, whereas older adults' performance was equivalent in the incidental and intentional conditions. A very similar result also was reported by Zelinski, Walsh, and Thompson (1978). They found that intentional recall instructions improved younger but not older adults' performance.

In general then, much of the age-related memory deficit observed in adults' list learning can be accounted for by inefficient strategy use by older subjects. While it is possible that further encoding deficits exist, such processing must be evaluated independently of retention. In several attempts to independently assess encoding, similarities rather than differences in the nature of encoding processes have been observed across adulthood. On the other hand, the results of several recent studies of adults' learning and retention of information assumed to be encoded automatically suggest a more severe processing capacity limitation in older than younger adults. Such processing capacity differences are likely to be an important factor in aging of the cognitive system.

There presently is no good evidence of age changes in storage capacity (e.g., Wickelgren, 1975). Indeed, present theoretical formulations of learning and memory seem to assume that if material is registered in secondary memory, it is not lost, although it may become inaccessible (e.g., Atkinson & Shiffrin, 1970).

There is considerable research on possible retrieval problems of older adults. One method used to evalute the relative importance of deficiencies in acquisition versus retrieval processes is to compare recall and recognition performance. While recall involves both acquisition and retrieval, recognition generally is assumed to involve mainly acquisition. That is, if memory is conceptualized as the creation of a trace, and recollection is determined by appropriateness of information in the retrieval environment, then the difference between recall and recognition resides in differences in the retrieval environment (see Perlmutter & Lange, 1978; Watkins & Tulving, 1975). For recognition a copy of the encountered stimulus is physically present, while for recall it must be cognitively retrieved. Thus, if retrieval plays a minimal role in recognition, then age deficits in recognition can be interpreted as reflecting deficits in acquisition or storage. On the other hand, greater magnitude recall deficits can be attributed to retrieval difficulties.

Empirical work generally has demonstrated larger age decrements in recall than in recognition. All investigators seem to find fairly large age differences in recall (e.g., Bromely, 1958). On the other hand, most investigators find either small but reliable (e.g., Botwinick & Storandt, 1974; Gordon & Clark, 1974) or nonsignificant age differences (Craik, 1971) in recognition. | A27 |

In a single study Erber (1974) examined age decrements in recall and recognition. While she found older subjects (60 years old) performed significantly less well than younger subjects (23 year olds) on both tasks, age accounted for 25% of the variance in recall, but only 10% in recognition. Thus, when retrieval demands are minimized, as in recognition, memory disadvantages of older subjects are reduced, but probably not eliminated.

Similarly, in the experiments summarized in Table 1, the age difference in standard intentional free recall tests averaged 13%, while in standard intentional recognition tests they averaged only 9%. This greater age difference in free recall, where retrieval demands were maximal, indicate again that retrieval difficulties contribute to age deficits in memory performance.

The results of several recall studies also demonstrate that older subjects are benefited more than younger subjects when good retrieval support is provided. Laurence (1967a) examined recall of 12 item lists, either all from a single conceptual category, or all from different conceptual categories. There was a highly significant age by list type interaction; while performance of older subjects was considerably worse than younger subjects on unrelated lists, it was only slightly worse on related lists. It is possible that when items from a single conceptual category were to be remembered the category concept served as an effective retrieval cue. In a subsequent cued recall study carried out by Laurence (1967b), age decrements were eliminated when category names were provided at retrieval. Thus, this finding adds to the interpretation that deficits in effective retrieval importantly contribute to older subjects' recall disadvantage. | A28 |

Craik (1968) also examined the effects of retrieval information on recall. He tested 22 and 62 year olds, manipulating the size of the pool items were drawn from (digits, counties, animals, and unrelated words). Age decrements in recall were attenuated with lists from small word pools. Thus, when adequate retrieval information is available, either by providing recall cues or using a limited set of items, older subjects' retention is less impaired.

Another idex that has been used for estimating relative retrieval versus acquisition deficits on categorized recall lists entails separate analyses of the number of chunks recalled, and the number of words recalled per chunk. The number of chunks recalled has been taken as an index of retrieval effectiveness, while the number of words recalled per chunk has been considered an index of encoding efficiency. Craik and Masani (1969) found that older subjects (72 year olds) recalled fewer chunks than younger subjects (22 year olds), but did not differ in the number of words recalled per chunk. Because the older subjects retrieved fewer chunks than younger subjects,the authors concluded that aging had a detrimental effect on retrieval, but because there were no differences in the number of words recalled per chunk, they concluded that aging did not affect encoding. It is not entirely clear, however, that the number of words recalled per chunk is a pure index of encoding efficiency. Furthermore, Hultsch (1975) found age deficits with both of these measures. Thus, the conclusion that aging does not affect encoding should be considered with reservation. | A29 |

Hultsch (1975) employed similar analyses, but perhaps more appropriately interpreted the number of words recalled per category as retention or accessibility of stored event information, and the number of categories recalled as a measure of accessibility of higher order memory units. Thus, both measures probably reflect retrieval and acquisition, but of different sorts of information. Three age levels (10, 59, and 70 year olds), and two recall conditions (free and cued) were used. The results indicated significant age differences in number of words recalled, categories recalled, and words recalled per category. Thus, this study indicates that adult age differences in retention probably reflect deficits in accessibility of higher order informaton, as well as availability of elementary information.

A repeated trials recall study by Buschke (1974) provides further evidence of retrieval deficits in the elderly. In this task subjects were given repeated trials of recall on a 20 word list that was only presented once. The results indicated greater variability in the pool of words older subjects consistently recalled from trial to trial. Apparently, many of the words were adequately acquired and stored, but on some trials there were retrieval failures.

In summary, several processing deficits have been demonstrated to underlie the poorer secondary learning memory performance observed in older adults. Early paired associate learning studies showed that elderly subjects suffer from acquisitional deficits. When level of original learning was equated, age-related retentional differences were eliminated (e.g., Moenster, 1972; Hulicka & Weiss, 1965; Wimer & Wigdor, 1958). Subsequent research has begun to delineate the nature of these acquisitional deficits. Hulicka and Grossman (1967), as well as Canestrari (1968), found that instructing subjects to use mediators diminished age decrements in paired associate learning. Denney (1974) found little clustering by the elderly, and Hultsch (1969, 1971) found instructions to organize (Hultsch, 1969), and sorting tasks (Hultsch, 1971), disproportionally benefited older subjects. A number of investigators (e.g., Craik & Simon, 1980; Erber, 1979; Eysenck, 1974; Perlmutter, 1978, 1979; Zelinski, Walsh, & Thompson, 1978) studied effects of various incidental learning procedures and found that tasks that controlled acquisitional processing attenuated age differences in recall. Thus, considerable evidence points to age-related deficits in acquisition. However, many findings suggest that the elderly suffer from production deficiencies (cf. Flavell, 1970) rather than inabilities. That is, diminished retention is improved when instructions to engage in appropriate acquisitional processing are followed. Moreover, when encoding under controlled conditions has been examined directly, (e.g., Mitchell & Perlmutter, unpublished manuscript; Perlmutter & Mitchell, unpublished data) age differences have not been observed. Thus, inefficient spontaneous use of effective encoding strategies, rather than encoding ability, per se, seems to be implicated as an important contributor to age-deficits in learning and memory. A30

Several other lines of research have indicated further mnemonic deficits in the aged. Investigations of recall and recognition have shown greater age-related deficits in recall than recognition (e.g., Botwinick & Storandt, 1974; Craik, 1971; Erber, 1972), and this finding has been taken to indicate retrieval problems in the elderly. Also, in recall studies in which retrieval support has been manipulated (e.g., Laurence, 1967a,b; Craik, 1968) it has been found that retrieval deficits contribute importantly to age differences; when adequate retrieval cues are provided, age differences are diminished. Likewise, measures of the number of categories recalled, and the number of words recalled per category on related lists (e.g., Craik & Masani, 1969; Hultsch, 1975), indicate age-related retrieval deficits of higher order information, as well as elementary information. Finally, a repeated trials experiment (Buschke, 1974) also demonstrated retrieval deficits in the elderly; older subjects evidenced greater variability in the pool of words they recalled consistently from trial to trial. Considerable evidence of age-related deficits in retrieval thus also has accumulated, but questions remain about the mechanisms involved.

Cognitive Skill Training. A few researchers have attempted to train cognitive skills in older adults. In two studies modifiability of intellectual functioning has been demonstrated (Hoyer, Labouvie, & Baltes, 1973; Labouvie-Vief & Gonda, 1976). However, in both of these studies transfer of training either was nonexistent or limited to closely-related tasks. On the other hand, Plemons, Willis, and Baltes (1978) demonstrated modifiability of fluid intelligence skills, as well as transfer of training effects. Moreover, these investigators were able to predict the extent of transfer on the basis of the relatedness of the transfer task to the training program. However, they found attenuation of the difference between their training and control group on a 6-month posttest that was attributable to practice gains in the control group. Thus, practice gains probably were not totally dependent upon the training program. | A31 |

The durability and transfer of enhanced performance due to training of older adults also has been documented in several other domains. Sanders and Sanders (1978), for example, found that elderly individuals trained to use an efficient strategy to solve unidimensional concept identification problems demonstrated better performance on a bidimensional conjunctive concept identification problem administered one year later. Additionally, research carried out by Sterns and his associates (presented in Sterns and Sanders, 1980) has demonstrated that sequenced training is effective in improving older adults' information processing skills needed for effective driving, and that these increments are maintained over at least 6 months.

Enhanced performance following training has been found on a number of Piagetian tasks as well. Hornblum and Overton (1976) reported rapid improvement in performance on a conservation of surfaces task for older adults trained with a feedback procedure. This training effect was much stronger than that from a non-feedback procedure. In addition, it resulted in transfer of training effects on four out of five transfer tasks.

Spatial perspective taking also has been a popular area for intervention research. Hoyer and Schultz (1976) found that older adults who were given visual auditory feedback on a perspective-taking task showed performance gains on both an immediate and delayed test, and that this improvement was greater than that of subjects in both a non-feedback practice and untrained control group. However, no transfer was evident for any of the groups studied. | A32 |

Zaks and Labouvie-Viev (1980) attempted to train social-cognitive functioning in older adults. They presented one group of elderly adults with a six-week training program consisting of discussion and role-playing of problems, and practice in taking both the listener and speaker roles in a referential communication task. A placebo group participated in separate discussion groups, but was not given the opportunity to engage in role playing, and received practice in only one role of the referential communications task. A control group received no training. On the spatial perspective taking task the training group performed better than the placebo group, which in turn outperformed the control group. On the referential communication task, the training group outperformed both the placebo and control groups, which were not different from one another. The authors concluded that while nonspecific training may facilitate performance on some tasks (in this case, the perspective taking task), the opportunity to engage in role-playing facilitated socio-cognitive skills above and beyond the effects of less circumscribed interaction

In summary, the possibility of training cognitive skills of older adults is well substantiated. Moreover, such training often has been found to transfer to tasks other than those used in training, and some information about the most effective training procedures is beginning to emerge. | A33 |

II. Real World Evidence of Adult Learning and Memory

Relatively little research on learning and memory in real world situations has been carried out, and this paucity of research is especially evident for learning and memory in informal situations (e.g., nonclassroom learning). Moreover, the little research of this kind that has been carried out has not had a developmental focus. Yet, it would seem that systematic evaluation of real world learning and memory, and age differences in such skills, would be useful. At the very least, such an analysis would permit the extension and validation of current laboratory based understanding of learning and memory, and its development. Moreover, since the learning and memory that takes place in everyday life tends to be consideralby more complex than that tested in most experimental studies, there is some reason to believe that important factors may be missing from current understanding. In addition, while it is possible that aging detrimentally influences the micro mechanisms of learning and memory most heavily relied upon to perform typical experimental tasks, aging may have a more limited adverse effect, or perhaps even a positive effect, on some of the macro learning and memory styles used in everyday life. Thus, information about older adults' everyday learning and memory poses a potentially unique data source for those interested in age differences and age changes in learning and memory. The scant literature on the use of such skills, in a sample of domains pertaining to physical skills, cognitive skills, and social skills, is summarized below. [A34]

Physical Skills

The biological deterioration that accompanies aging may provide impetus for learning and compensation. Just as the developing child must learn to cope with rapid physical growth and hormonal change, the aging adult must learn to adapt to sensory loss and skeletal, muscular, and other organic deficits. In this section the impact of physical training on physiological and psychological functioning of older adults, and their adaptation to loss of sensory functioning, are discussed.

Physical Training. Age-related losses in physical skills are well documented (e.g., Asmussen et al., 1975; Astrand et al., 1973; Atomi & Miyashita, 1974; Dehn & Bruce, 1972; Drinkwater et al., 1975; Kilbom, 1974; Profant et al., 1972; Robinson et al., 1976). While these losses at least partially are attributable to physiological aging *per se*, they probably also reflect undiagnosed disease and loss of fittness associated with reduced activity. Of concern for the present purposes is evidence about whether older adults profit from physical training. | A35 |

DeVries (1975) has indicated that early studies left doubt about the possibility that older adults' physiological functioning could be improved through intervention. However, since the mid-1960s numerous studies have demonstrated enhancement of aerobic capacity and cardiac functioning following training in both elderly men and women (Adams & DeVries, 1973; DeVries, 1970; Hartley et al., 1969; Kilbon et al., 1969; Saltin et al., 1969; Sidney & Shephard, 1977). Several additional points also emerge from this more recent research. First, those who begin training programs in poorer physical condition show the greatest gains, regardless of age (DeVries, 1970; Kasch & Wallace, 1976). Second, if compared on a percentage basis, older individuals demonstrate gains comparable to younger adults (Adams & DeVries, 1973; DeVries, 1970; Hartley et al., Saltin et al., 1969; Suominen, Heikkinen, & Parkatti, 1977). Third, while it may not be necessary to require maximal exercise to obtain improvement in aerobic capacity (DeVries, 1970; Suominen, Heikkinen, & Parkatti, 1977), type of exercise probably is important. For example, DeVries (1975) argued that the rhythmic exercises (e.g., running, jogging, and swimming) utilized in most training programs yields optimal results. | A36 |

Other areas of elderly functioning also have shown improvement following physical training. Suominen, Heikkinen, and Parkatti (1977) found improved metabolism in skeletal muscle and connective tissue, measured by enzyme activity, following eight weeks of various exercise activities (e.g., walking swimming, gymnastics). Ehsayed, Ishmail, and Young (1980) documented significant increases on measures of fluid, but not crystallized, intelligence for both young and old men following a physical training program. In some studies changes in personality variables related to physical training also have been reported. For example, Young and Ishmail (1976) and Sharp and Reilly (1975) have noted increases in conscientiousness and persistence in older males following participation in a physical fitness program. Hartung and Farge (1977) have documented personality traits of middle-aged runners and joggers, although the directionality and causality of their findings remain unclear. DeVries (1975) has suggested that physical training may have a greater sedative effect than popular tranquilizers for anxious adults. Finally, participation in exercise programs has been found to increase health and exercise consciousness (Gutman, Herbert, & Brown, 1977; Sidney & Shephard, 1977; Thomas, 1979). | A37 |

It should be evident that the question posed at the beginning of this discussion has been answered with a definitive yes. In virtually every study reviewed, older adults have shown significant improvements in physiological and intellectual performance following training, and this improvement has been quite comparable to that observed in younger adults. However, to date there have been few studies in which the differential efficacy of various types of exercise on elderly functioning has been investigated (a study by Gutman, Herbert & Brown, 1977 is an exception). Likewise, the issues of length of time of training for optimal benefits, individual differences in response to exercise programs, and effectiveness of various presentation methods, have not been addressed empirically.

Sensory Adaptation. Detrimental effects of aging on sensory function apparently is universal (e.g., Corso, 1977; Fozard et al., 1977). For this discussion only the adaptations that older adults make to deteriorations in sight and hearing are considered. It will be argued that although there are substantial declines with age in the quality of information received from sense organs, older adults learn to compensate for these deficits, at least to some extent.

One of the most common and clearly established age-related decriments of visual function concerns dark adaptation. It has been found that rate of dark adaptation slows with age, and that final level of dark adaptation is lower in older than younger adults. An important implication of these changes is reduction of vision during night driving. Yet, there has been little research on the adaptation of older adults to night driving conditions, and vision tests for driver's licenses do not include assessments of such skills. Nevertheless, there are several ways in which older adults may accommodate to diminished vision associated with reduced dark adaptation. They can learn to look to the lower right corner of the windshield when oncoming headlights are detected, rather than looking directly at them. In addition, they can learn to anticipate problems while driving and to take advantage of environmental context. | A38 |

Auditory losses also are common in later adulthood, with most older adults experiencing some prebysicius. This auditory change is characterized by a loss of hearing for high-frequency sounds. A person suffering from prebysicius may not hear telephones ring, may have difficulty hearing human voices, particularly those of women, and may have problems in intelligably interpreting speech, since consonants such as F, S, and Z are paraticularly difficult to hear. Thus, loss of hearing associated with prebysicius has implications for both the safety (e.g., detection of warning signals) and social communication of older adults. While environmental (e.g., amplification and frequency of signals) and mechanical (e.g., hearing aids) adjustments can reduce the negative impact of hearing loss associated with prebysicius, such aids are not entirely effective.

However, over time older adults learn to adapt to some of the limitations of these aids (e.g., over amplification of sudden low-frequency noises). Moreover older adults who experience hearing loss learn to compensate for it by depending more on lip reading. | A39 |

Cognitive Skills

Cognitive development is recognized as an important aspect of early childhood. The advent of compulsory education and the theoretical views of Piaget have contributed to this emphasis on cognitive functioning in childhood. However, until recently interest in cognitive development beyond adolescence has been meager. Adults engage in formal education far less frequently than children. In addition, Piagetian theory, as well as most other perspectives on cognition, assume that cognitive development ceases at the time of maturity. Yet, there is no evidence to refute the possibility that cognitive functioning continues to develop beyond adolescence. The prevelance of second careers, job-related retraining, and continuing education, attest to the ability of adults to acquire new information, refine acquisition skills, and develop strategies for coping with cognitively complex and changing environments. In this section attention is directed to the role of media exposure and formal educational experiences on cognitive learning in later adulthood.

Media Use. Adults make extensive use of media in today's society, and although much of this interaction with newspapers, magazines, books, radio, film, and television is geared toward entertainment and recreation, some is motivated toward a desire to increase understanding and competence. For example, about 60% of adults in the United States report regular use of newspapers to meet specific information needs, 40% report such use of magazines, and about 35% report such use of books (Knox, 1978). While the extent to which adults read newspapers, magazines, and books is highly associated with level of formal education, it is only slightly associated with age (Parker & Paisley, 1966). Even so, adults who continue to read beyond the age of 60 tend to read material that is readily available; there is a decline in their use of printed material that must be obtained outside of the home (e.g., books from libraries and bookstores). | A40 |

More than half of the adults in the United States report regular use of electronic media to meet specific information needs (Knox, 1978). When entertainment and informational use of electronic media are combined, there is a slight decrease in usage in old age (Knox, 1978). However, when informational use of electronic media is analyzed separately, a different pattern emerges; informational use of both radio and television increases in later adulthood (Parker & Paisley, 1966).

It appears, then, that educationally oriented use of media is extensive in today's society, and that considerable use of television extends to cohorts that have not experienced this medium during their early years. Research that focuses on the educational impact of media, particularly for adults, still needs to be carried out. However, it is clear that much adult learning is accrued through media, and that such technologies may be useful in providing information to the elderly about important topics, such as consumerism, health, nutrition, and politics.

Formal Education. Lifelong education (also referred to as adult education, recurent education, or permanent education) recently has received considerable attention by psychologists, sociologists, and educators (Biren & Woodruff, 1973; Huberman, 1974; Havinghurst, 1976; Schaie & Willis, 1978; Sterns & Sanders, 1980). Moreover, each year during the mid-1970s about 25% of the adults in the United States engaged in at least one major continuing education activity. This percentage represents about a 5% increase over a single decade (Knox, 1978). | A41 |

The increased interest in continuing education probably derives from the changing American age structure and educational level (Knox, 1977), rapid technological advancement and obsolescence of knowledge (Dubin, 1972; Wroczynski, 1974), increases in multiple careers (Birren & Woodruff, 1973), and changing roles of women in the labor force (Troll, 1975). While there has been much discussion of the underlying assumptions (e.g., educational rights, societal necessity, and developmental imperatives) and goals (educational equality, prevention, and intervention) of continuing education, there has been little research to identify methods and strategies that optimize adult learning in formal educational settings. Moreover, little is known about age differences in the effects of continuing education.

Nevertheless, it is known that participation in continuing education declines with age. The highest participation rate is 29% in the 20s, followed by 26% in the 30s, 21% in the 40s, 16% in the 50s, 10% in the 60s, and 4% in persons 70 or older (Knox, 1978). Part of this age-related decline undoubtedly is due to location, topic, schedule, and cost. In addition, it is well established that level of prior education is highly associated with extent of participation in continuing education (e.g., Johnson & Rivera, 1965; Knox & Videbeck, 1963; London, Wenkert, & Hagstrom, 1963; Parker & Paisely, 1966), and level of formal education of today's older population, of course, is known to be lower than that of younger adults. The percentage of adults with only some grade school experience who participate in continuing education during a year is only 6%, while it increases to 9% for those who have completed eighth grade, 15%

for those with some high school, 24% for high school graduates, 36% for those with some college, 39% for college graduates, and 47% for those who have completed a year or more of graduate education (Knox, 1978). | A42 |

The reasons that adults engage in continuing educational activities varies greatly, but there seem to be some systematic shifts with age. More specifically, occupational considerations are most influential for young adults, leisure interests are more central during middle adulthood, and general information and social contact increases in importance in later adulthood (Hendrickson & Barnes, 1967; Johnstone & Rivera, 1965).

Although the needs of older learners have not yet been assessed adequately, many colleges and universities have shown their receptivity to this segment of the student body. For example, they have instituted, modified, and individualized curricula, and offered courses at a variety of geographic centers. All of these changes serve to increase the availability and flexibility of accredited education, and to make it more attractive to older adults.

Although continuing education appears to be gaining an increasing role in American society, at least for the forseeable future its role is likely to remain relatively modest. Nevertheless, its potential for reducing age differences is appreciable. To date, however, little or no documented evidence is available concerning how programs that exist enhance the lives of participants, nor have the relative merits of various programs for different segments of the population been examined. Such data would be invaluable for assessing developmental and cohort changes in learning and memory. | A43 |

Social Skills

Learning social skills and roles is a life-long process. Acquisition of these competencies typically is an informal learning process, whereby the ritualization of interactions, adjustment to new relationships and roles, and fine-tuning of interpersonal skills proceeds in a trial-and-error fashion, with peers, parents, and teachers serving as corrective guides. By adulthood it often is assumed that styles of interaction and patterns of adjustment are well established; the main social changes that are observed in adulthood have been viewed as idiosyncratic rather than developmental in nature. However, adults often are faced with new social demands for which they may not have the requisite social skills. Entry into a career, marriage, parenthood, and widowhood are examples of social transitions for which people have only a limited repetoire of the required skills. In this section retirement is considered as another such transition; the older adult must define and learn to meet the demands of this major role change. In addition, the older adult, as any other adult, may have difficulty dealing with day to day demands. The efficacy of psychotherapy as an avenue for older adults to acquire new patterns of adjustment and to learn social skills is also considered. | A44 |

Retirement Adjustment. Much of the research on retirement has focused on retiree's adjustment, satisfaction, and attitudes, often attempting to relate retirement success to a multitude of variables, such as health, income, education, occupational status, and work orientation. Until recently researchers have not considered retirement planning as a potential influence on retirement success. Retirement planning, either informally (e.g., through discussions with friends, colleagues, and family), or more formally (e.g., through participation in community or company based pre-retirement programs), is an active process of learning about the social role of a retiree, the benefits and options of retirement, and the process of adjusting to it.

Little is known about the impacts of informal methods of learning about retirement, although the vast majority of older workers rely exclusively on this process of information acquisition. There has been virtually no research to assess how this information is acquired, what the content of it is, how much of it is retained, and what impact it has on the retiree. The only available description of this learning mode is from a study carried out by Simpson, Back, and McKinney (1966). They assessed the extent to which a population of workers, categorized by occupation level, sought information from a variety of sources. They found that most of pre-retirees at all occupational levels received information from retired people, fellow workers, and the media, rather than from company officials or social security personnel. | A45 |

Still, relatively formal retirement planning programs are increasing in number. The main goals of such planning programs can be viewed either as counseling or planning (Kasschau, 1974). Programs that focus on counseling seek to reduce worker anxiety about retirement, dispel myths and sterectypes about aging and retirement, and affect changes in workers' attitudes toward loss of the work role. On the other hand, programs that focus on planning seek to provide the older worker with information about concrete steps that may be taken to insure a comfortable transition into retirement, such as information about pension benefits, financial planning, legal planning, medical benefits, health care, nutrition, exercise, and activity planning.

The overwhelming majority of research has indicated that older workers are less interested in the topics emphasized by counseling oriented programs (Kalt & Kohn, 1975), and that they engage in fewer such programs (Kimmel, Price, & Walker, 1978). In addition, research has shown relatively few measurable changes following counseling programs, perhaps because they are designed to modify attitudes and morale, which may be relatively difficult to influence

(Glasmer & DeJong, 1975; Tiberi & Boyack, 1979). On the other hand, evaluation of planning programs has demonstrated that they typically are quite successful. Stimulation of planning and acquisition of information has been documented following many retirement planning programs (e.g., Glasmer & DeJong, 1975; Tiberi & Boyack, 1976). | A46 |

The effectiveness of different types of planning programs has received only minimal evaluation. In one relevant study (Glasmer & Dejong, 1975) workers were exposed to retirement information in group or individual sessions. While the lecture-discussion format appeared most effective, as the authors noted, the greater amount of time spent in group discussion precludes confidence in this finding. In another study (Sieman, 1976), it was found that older adults learned as much as younger adults when the information was presented in a self-paced programmed instruction format. Thus, programmed instruction may provide a relatively inexpensive method of transmitting information to elderly adults.

Psychotherapy. It has been estimated that 17% of the elderly currently manifest psychological impairment severe enough to affect their daily functioning (Abrahams & Patterson, 1978-79), and that the prevalence of all forms of psychological disorders in the elderly is about 30% (Whanger & Busse, 1975). Moreover, although only 10% of the population is over 65, this cohort accounts for 25% of all reported suicides (Butler, 1975). When these statistics are juxtaposed against the finding that only about 5% of the people seen in community health clinics are over age 65, the incidence of unserved needs becomes real.

Since the writings of Freud, therapy for older adults has been deemed useless. The emphasis on resolution of early conflicts in psychoanalysis led to the view that persons over 50 years of age would not profit from extended psychotherapy. It was thought that their conflicts would be too rigidly embedded in their personalities to allow sufficient time for change. However, by now the notion that older adults are unresponsiveness to therapy generally is presumed to be a myth (see Knight, 1979-80; Karpf, 1980). | A47 |

It is unclear, however, whether there are age differences in the effectiveness of various therapeutic techniques. Knight (1979-80) argues that therapies typically used with younger adults are appropriate for aged populations as well (e.g., dynamic psychotherapy, family and marital counseling, sex therapy, behavioral intervention, and group therapy). Thus, according to Knight the selection of a therapeutic technique depends more on the nature of the problem than on the age of the client. Still, as Knight points out, the elderly have concerns that are unique to their cohort.

Moreover, Butler and Lewis (1973), consider age specific therapies for the elderly appropriate. In particular, they have suggested that life review therapy is especially suitable for older adults, since it capitalizes on the normal phenomena of reminiscence in old age. Life review therapy facilitates the older adults' reorganization of past events to permit him or her to gain perspective and self-understanding of life cycle patterns, that, in turn, raise self-esteem and decrease anxiety. An exploratory study of the efficacy of behavioral group therapy ("here and now") and life review group therapy ("there and then") indicated greater gains in self-esteem and greater reductions in anxiety and incidence of somatic behavior for participants in the life review therapy group (Ingersoll & Silverman, 1978). However, the extremely small sample sizes, lack of adequate control groups, short duration of therapy, and inability to control extraneous variables, precludes definitive comparison of the two techniques. Clearly, more research on the effectiveness of various therapy techniques with older adults needs to be conducted, with greater attention needs to be directed to individual differences in responsiveness to various types of therapy. | A48 |

III. Conclusions About Learning and Memory Through Adulthood

There has been much research aimed at assessing learning and memory skills of older adults. In general, age-related deficits in performance on laboratory tasks have been observed. However, the magnitude of these group differences often are relatively small. In addition, performance curves of younger and older groups typically overlap. That is, some older adults perform better than some younger adults. Thus, while research consistently indicates that there are age-related deficits in adults' learning and memory, a somewhat moderated perspective on these deficits probably is called for. For example, even if the observed age differences can be assumed to reflect age changes (which they probably cannot), it appears that, to the oldest age typically included in experimental studies (e.g., 60-70), an adult's learning and memory performance probably will fall within the same quartile of the population's distribution as it did during early adulthood. The point is that although there seems to be some age-related decrement in learning and memory performance, age does not turn out to be a particularly good predictor of performance.

Moreover, the relevance of laboratory learning and memory performance to real world learning and memory situations remains unclear. An assumption of the experimental approach has been that there are basic principles of learning and memory, and that these principles can be understood best by experimentally dissecting each relevant factor. Unfortunately, while this approach allows investigators to gain knowledge of the particular variables studied, within the confines of the particular situation in which they have been investigated, it may not help in assessing the relative importance of these variables (i.e., variance accounted for] in different situations in which other factors also are present. This predicament is especially problematic if the effects of variables are not additive. That is, if variables interact, main effects from separate experiments may not simply be summed, since estimates of all interaction effects also are needed to account for performance. In essence, then, confidence in the value of findings from laboratory experiments must rest upon subjective assessments of the importance of the variables that have been investigated, and on faith that interaction effects have been adequately taken account of. It is essential, therefore, that the relevance of experimental tasks to real world tasks be assessed. | 149 |

In the meantime, however, some perspective may be gained from recent views of cognition that have stressed the interaction between basic cognitive processes and acquired knowledge (e.g., Chi, 1978; Perlmutter, 1980). Very briefly, it has been found that learning and memory performance is affected by one's familiarity and expertness with material to be learned and remembered, as well as by one's familiarity and expertness with material relevant to it. It appears that new knowledge is acquired and retained within old knowledge structures. Thus, when familiar with material to be learned and remembered, or to material relevant to it, an individual is aided by his or her existing knowledge structures, which provide him or her with something on which to tie the new informarion. In addition, it appears that with previous familiarity, information can be organized more tightly, and thus assessed more easily.

It is possible, therefore, that the increasing amount, and overlearning, of information in the knowledge base of older adults permits them to perform many ecologically valid learning and memory tasks as competently or more competently than younger adults, in spite of less effective learning and memory mechanisms.

That is, while older adults' deteriorating learning and memory mechanisms may lead to increased learning and memory failures, their enriched knowledge bases may permit them to demonstrate equal or better learning and memory than younger adults, at least on some tasks. Thus, if learning and memory tasks are characterized in terms of the processes and knowledge required for successful performance, the pattern of age differences in adults' performance may be predicted. To the degree that performance depends upon basic learning and memory processes, younger adults will be favored over older adults; but to the degree that performance depends upon acquired knowledge, older adults will be favored over younger adults. | A50 |

It should be noted too, that although there has not yet been much systematic developmental research on real world learning and memory, there certainly is some evidence of effective real world learning and memory in later adulthood. Therefore, the perspective taken in this paper has been that effective learning and memory are life-long activities. While this perspective seems unequivical, in fact, it has not been central to many theoretical or practical considerations of adulthood. Rather, previous conceptualizations of adulthood have tended to view adults as having fixed or declining modes of functioning. Perhaps it has been the recent advent of large numbers of adults, surviving literally fifty or more years of adulthood, that has called this view into question. Still, the full promise of growth and change during adulthood probably has yet to be appreciated. Hopefully, systematic research on possible age limitations, and especially advantages, in real world learning and memory situations will be forthcoming. Such research would have extensive theoretical as well as practical import.

IV. Possible Explanations of Age-Related Deficits in Adult Learning and Memory

It just has been argued that a crucial step for future research is the assessment of cognitive function in real world situations. Still, a clarification of the causes of the age differences already documented in laboratory situations certainly should be forthcoming. At present, several factors have been hypothesized as viable explanations of cognitive aging. Unfortunately, however, there is scant empirical validation of any of them. In this section some of these hypotheses are considered. | A51 |

Age

Age obviously is the focus of developmental considerations of cognitive functioning. It is not so obvious, however, how age should be conceptualized.

First, while age is a convenient and exact index of passage of time, it also is an inexact index of numerous other confounded, and often unrecognized, variables. For example, age is quite predictive of biological state, and although less accurate somewhat predictive of education, income, lifestyle, and life events. Thus, even if age differentiated individuals in terms of learning and memory skill, it would still be unclear what in the age variable actually was relevent. Since some components of the age variable might be more predictive of performance than the conglomerate variable, it is essential that relevant factors be considered individually.

In addition, while age can be used to index passage of time, it is not entirely clear what referrant is most relevant for indexing age in adulthood. For example, chronological age indexes time since birth, and generally is the age variable that researchers have attempted to estimate. On the other hand, time since completing formal education, or time until death, actually may be more relevant variables for aging.

To illustrate, it seems pertinent that younger subjects in aging studies typically are college students, who routinely are faced with tasks that are similar to experimental learning and memory tests, while older subjects typically have been out of school for many years, and rarely are faced with tasks at all comparable to experimental learning and memory tests. It is likely that younger adults' greater recent experience in utilizing learning and memory strategies that are appropriate for laboratory experiments contributes importantly to the results that are obtained. Thus, it may be approxiate to consider age since completing education, as well as age since birth. Indeed, it would be useful to compare several samples of same age since birth adults who differed in time since schooling. | A52 |

Similarly, it has been demonstrated that regardless of age, fairly substantial declines in intellectual performance often are evident several years prior to death. This terminal drop phenomenon (e.g., Siegler, 1975) may account for much of the age difference typically reported in cognitive studies. That is, increasingly older age groups of adults are likely to include greater numbers of subjects in the terminal stage. It therefore would be useful to carry out post-hoc analyses that excluded subjects who had turned out to have been tested in the terminal stage. In addition, research designs could include several same age since birth samples with different estimated ages until death.

Cohort

It has been argued (e.g., Schaie, 1970, 1973) that age deficits observed in cognitive performance can be accounted for by generational or cohort differences. Very briefly, the point is that cohort-specific experiences are completely confounded with passage of time. That is, since passage of time is uniquely experienced by each generation, it is impossible to draw conclusions about age differences that ignore cohort factors, or to draw conclusions about effects of passage of time that are totally generalizable across generations.

This problem is likely to be relevant to considerations of age differences in learning and memory studies. For example, if age of adults is a good predictor of number of years of education, and if number of years of education affects learning and memory performance, then random sampling would produce age differences that should be attributed to level of education, rather than to development *per se*. In order to determine whether additional factors contribute to age differences researchers should control level of education. At a subtler level, however, cohort effects could imply that another less quantifiable factor is highly correlated with age, even when educational level is controlled. For example, it is possible that over the years, equal numbers of years of formal education fail to produce equivalent effects. Fewer years of schooling in today's television-oriented society, for instance, might be sufficient to produce levels of knowledge that are comparable to that which required much longer attendance at school in the past. Alternatively, fewer years of schooling in an earlier, more disciplined time in history might have produced greater scholarship than they do today. Thus, perfect controls for cohort effects often are extremely difficult, if not impossible to establish. | A53 |

Expectation

Another possible explanation of age-related learning and memory deficits is expectation decline. There presently are many stereotypes about mental impairment in old age, and some evidence that psychological function can match expectation. Thus, older adults' poorer performance at least partially may be attributable to their fulfillment of an aging role. If this hypothesis is correct, negative correlations between high expectation of learning and memory impairment and learning and memory performance would be expected. Of course, such correlations would not indicate a causal direction of the relationship, although the lack of such findings would invalidate the hypothesis. A longitudinal analysis of this hypothesis surely is called for.

Disuse

Another possible explanation of age-related learning and memory declines involves disuse. It is possible that formerly acquired strategies become functionally less available if they are not used often. That is, because of disuse, learning and memory strategies that were once well established may be forgotten or become less well-established, exhibiting deficiencies typical of strategies not well established. It seems likely, for example, that disuse can account for some of the production deficiencies observed in the elderly. Since certain life roles tend to place more or less learning and memory demands on people, assessing individuals' learning and memory demands would permit some assessment of the disuse hypothesis. If learning and memory demands correlate with learning and memory performance, the hypothesis would be supported. Of course, other self-selection factors also could contribute to the relationship. | A54 |

Depression

Depression has been found to be associated with cognitive deficits (e.g., Miller, 1975; Zelinski, Gilewski, & Thompson, 1980). Moreover, a disproportionate percentage of older adults apparently suffer from depression (e.g., Whanper & Busse, 1975). It is possible, then, that some of the age differences observed in studies of cognitive aging are attributable to depressive subjects in the older samples. Separate assessments for depression may be called for.

Biological

Finally, the hypothesis of a biological basis to learning memory decay in later adulthood has been quite prevalent (e.g., Albert & Kaplan, 1980; Butters, 1980; Jarvik & Cohen, 1973). This notion suggests that physiological wear and tear, biochemical changes and/or poor health reduce older individual's mental capacities. While there is still little understanding of the exact nature of the relationship between biological and cognitive function, the known age-related changes in the central nervous system and health certainly cannot be ignored. These factors almost surely are in some way related to cognitive performance. Future research that combines biological and psychological assessment certainly is called for. | A55 |

Oral Health Needs of the Elderly
MANPOWER TRAINING AND HEALTH CARE DELIVERY SYSTEMS

REPORT FOR WHITE HOUSE CONFERENCE
ON AGING 1981

Sholom Perlman, D.D.S., M.S.
University of Colorado

ORAL HEALTH NEEDS OF THE ELDERLY: MANPOWER TRAINING AND HEALTH CARE DELIVERY SYSTEMS

A Report for the
White House Conference on Aging, 1981

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University of Colorado

A look at the last ten years' progress in oral health for the aging shows a nation more keenly sensitive and concerned, but with no clearly defined health or social policy on the subject, still struggling to meet the demands of the elderly on a localized basis and still focussed intently on cleaning up the backlog of unmet needs more than on the search for rational approaches for eliminating the origins of those needs before the load becomes totally overwhelming in the future.

The country as a whole, and the federal administration in particular, continues to pursue improvement of oral health for the elderly in research, manpower training and the delivery of health care as though these three main lines of effort were independent sectorial entities. The three are closely intertwined, however: any significant advance in one of them quickly affects the direction and intensity of effort and development that must be applied in the other two.

The responsibility before us is two-fold: to develop the long-range health- and wellness-promotion systems for the impending future and, at the same time, to evolve efficient systems for dealing with the backlog of human needs for care until their origins can successfully be eliminated or controlled.

This report delineates an overview of the main parameters of the whole oral health problem in systematic rather than unitary terms, emphasizes the prime importance of removing the economic barriers to progress on the issues, presents some general considerations for emphasis in dental manpower training and the delivery of oral health services to the elderly, and explores several component areas of the total system from the standpoints of achievement up to now and new directions for research and development in the future. The needs for basic dental research on aging are treated in another position paper (Baum) and should receive equal attention and support.

INTRODUCTION AND BACKGROUND

> The demand for greater accountability makes imperative effective, efficient health care management....Problem solving by anticipating the event rather than solving problems by dealing with what has has already occurred should be our aim.[1]

Our immediate potential for delivering dental care to the elderly portion of the population depends heavily upon the kinds and numbers of dentists, dental hygienists and dental auxiliaries, including dental technicians, who are available today and both eager and qualified to take care of older people. Empirically, in each individual community, current delivery programs rely upon the personnel who are currently available to participate; as a result, each delivery program reflects the special talents and capabilities of its own particular manpower team.

But, conversely, the kind and intensity of manpower training for the future will depend upon what dental care delivery systems are contemplated for the future. Many ideas for geriatric dental care systems are put forward but, as yet, there is neither widespread professional or consumer consensus on what models show most promise, nor is there a national policy on what directions are considered worthy of most diligent pursuit for the greatest public good. Accordingly, there is no sound basis for deciding either the nature or the number of dentists, hygienists or other geriatric specialists who should be trained and developed. Yet we are faced daily with the responsibility of making important decisions without a satisfactory base for them.

To achieve rational consensus, let alone national policy, in the present climate is difficult indeed, because too little still is known about the dental and oral health needs of the elderly today, and there are no reliable projections of their probable needs for services in the years ahead.

Determination of the needs is not accomplished simply by conducting surveys to count the numbers of edentulous mouths, missing teeth, unfilled cavities, periodontal diseases, anatomical or functional defects, soft tissue lesions, or possible malignancies in various age-strata. These are measures of disease or of loss. They are not equatable with need for services. Many people with such conditions reject professional judgment, decline and refuse treatment or even educational services and continue to function at a level that is satisfactory to them. Health professionals may view the need for their care as urgent, but when large numbers of such individuals disagree, the real demand for services and specialized manpower will have to be adjusted downward from that indicated by the clinical surveys alone.

This universal discrepancy between "professional judgment need" and the "patient-perceived need" is especially large and more widely prevalent in the elderly. It severely complicates the problem of estimating the country's eventual demand for services and it confounds efforts at rational planning at all levels, national and local. Oral health status is a function not only of professional criteria but of cultural, ethnic, emotional, economic and individual considerations as well. In poverty and in other cultures the absence of dentures in the mouths of elderly citizens often is regarded as normal oral health status; whereas in other groups the display of flashy dental gold appliances is viewed as a more desirable oral health status than the retention of one's own natural teeth in healthy condition into older age.

Because oral health status and priority perceptions may well vary significantly for different segments of the older population, it is difficult to establish a universally acceptable national policy on oral health for the elderly. In the absence of a clear and specific national policy, national efforts in research, in serving critical needs and in promoting the maintenance of high levels of oral health and wellness remains fragmented; and planning for development of the necessary manpower remains confused.

Moreover, unification or centralized coordination of the various elements continues to be difficult because of administrative and program limitations. In our society, it still falls to the federal government to finance the initial exploratory research and trials for those innovative proposals in health care which the professional and industrial sectors do not yet perceive to be sufficiently promising or otherwise worthy of risking their own developmental funds. But the development of comprehensive interdisciplinary systems requires tightly coordinated multi-agency support and collaboration. Such concerted, mission-oriented programming is seldom obtainable under the present territorial structure of federal and state funding units.

The driving force behind all considerations of oral health, for the elderly more critical than for the young who can cope more flexibly with new demands upon their income, is money: the money to pay for treatment, for services and for the necessities that attach to the maintenance of good oral health once it is established. The nation's dental bill for 1979, based upon dollars paid for the dental care provided by dentists, hospitals and clinics, was reported to be $13.6 billion[2]. That figure excludes the cost of toothpaste and other items of home-hygiene care.

In the balance opposite that cost are the uncounted millions paid into the economy for commercial dentifrice advertising, insurance premiums, professional and paraprofessional education, basic and clinical research, consumer health education and school health programs. But little of this input is directed for the special benefit of the elderly.

The biggest obstacle, in virtually all current programs of oral disease care for the elderly, is at the bottom line: lack of money to pay for needed treatment. Whether in private dental offices, public clinics, or in special programs for seniors, the needy elderly have greatest difficulty in paying for their dental service needs. Health insurance programs help meet the cost of their medical care, but what little is provided for their dental treatment from private or public insurance, government-funded aid or public and private charitable sources reaches only a small proportion of the potential demand, and is not only usually too little but is earmarked for a too limited array of dental services. Unarguably, older people should be encouraged and helped to allocate their own personal resources for needed dental care where possible. But only with the inclusion of dental benefits at adequate dollar levels in private and public assistance programs for the elderly will any nation-wide solution to their oral health problem be successful; without such inclusion failure is virtually a certain consequence.

To devise proper strategy for attacking the short-range and the long-range aspects of oral health for the aging, all of the main interrelated issues must be addressed holistically, rather than piecemeal as in the past. The identification of appropriate directions for ev olving health care delivery systems suitable for every segment of the growing elderly population requires a global rather than provincial approach.

Inasmuch as its mission is primarily to project future directions for the entire national effort for the elderly, rather than to focus categorically upon traditional or institutional segments of the problem, the White House Confernce on Aging is probably the ideal forum for initial examination of these varied and far-ranging issues.

I. THE PROBLEM OF ORAL HEALTH STATUS AS A DETERMINANT OF ORAL HEALTH POLICY FOR THE ELDERLY.

1. *Epidemiology and professional estimation of oral health needs.* National and regional estimates of of the oral health needs of the American population are sparse and none of them answers even the over-simplified three-level question of how many elderly people are in a state of "good" oral health, how many are in "poor but not functionally disabling oral health and how many are "urgently in need" of oral health care. No large-scale oral health surveys of the elderly have been made since the National Health Survey sample observed by examiners of the US Public Health Service in the early 1960's, and the Health and Nutrition Examination Survey (HANES I) of 1971-74. Allowing the assumption that the frequency distributions by various ages and other population parameters are essentially the same for today's population as they were at the time of those studies, estimations projected from those distributions may provide a qualified indication of the main elements of the situation today. On that basis, using the 1979 census projections for the elderly population, estimates can be calculated as shown in Table I.

No reliable data or estimates appear to be available on many other needs, such as treatment of pain and acute infections, temporomandibular arthropathy, anatomical functional disabilities, lesions of the tongue and soft tissues, xerostomia and other physiological dysfunctions and cancer.

All surveys emphasizing disease and needs for treatment perpetuate the traditional negatively-oriented practice of focussing upon crisis-care, which is sick-care, rather than upon health care as a national goal, and the essentiality of learning how to prevent crisis-development and avoid having to use the sick-care system so much. The three-level question, which must be addressed as a prerequisite to planning for delivery systems and manpower, is not answered by such statistical information alone.

2. Oral Health Status and the Conception of Health Delivery Systems and Manpower Production. Epidemiologic surveys are not by themselves indicators of the population's needs for care nor of its probable demand for and utilization of services. In the HANES I, conditions were also classified according to whether they did or did not require certain specific treatment, thus providing an estimate of needs, in the professional judgment of the examining dentists. But without consideration of what the owner of an observed condition and need will probably do, or would wish to do about it if he could, even such professional judgments do not provide sufficient basis for determining what kind of health service delivery system should be developed or, correlatively, what manpower training programs should be evolved. Experiential utilization rates are limited by their own contemporaneous access conditions[3].

The perceptions of the elderly about their own oral health are critical to policy-formation and to subsequent planning, for corrective services, for preventive measures and for manpower development. Maturity and aging appear to be accompanied by increase in the tendencies toward toleration of insidious progressive chronic discomforts and disabilities, and toward resistance against innovations or interventions that might result in change of state or of habits or might otherwise disturb the calm, repetitive course of daily living. It is well-known that older people often prefer to refuse dental or medical treatment of many kinds simply because they reject the prospect of getting into a new situation that might unpredictably require the making of an undesirable, or even just an additional, adjustment to their established life-styles.

Study would be desirable, however, to elucidate the underlying reasons for such resistance especially where health is concerned, with a view toward discerning ways to achieve improvement in attitude and in health behavior, especially when some critical health consideration is in the balance. Moreover, the perceptions of the elderly about oral health may be significantly different from their perceptions about general health, and the delivery of dental care may require an approach that is importantly different from current models for delivering medical care.

3. Standards of Oral Health and Wellness: Prerequisites to Planning. One corollary of this line of procedure could be the elucidation of a series of standards to define an acceptable model of an "orally healthy individual", at successive levels of maturation and aging. Without such target models of "good oral health" or "oral wellness", it is difficult to set positive goals for any health program, except one which is aimed only at crisis-level care and treatment of those who seek it under the pressure of crisis conditions. If we can agree on our picture of what a "healthy" older person is entitled to have or entitled to be able to do at certain ages or life-stages, we could then count how many are already healthy and how many are at certain (defined) levels or classes below that defined standard; and through simplified monitoring we could even identify specifically the ways in which the standards are or are not being met. Planning could then proceed on the basis of positive, realistic, quantifiable, and numerically-measurable goals such as:

> Within five (or 10) years the proportion of "healthy" 65-year-olds will be increased by 10 percent; the proportion of "almost healthy" will be improved by 15 percent and the proportion of those in "critically poor health" will be reduced by 25 percent.

Goal-setting of this kind is currently being applied in other situations, including the Indian Health Service of the USPHS and, at least with respect to child populations, in various parts of the world. Once American norms have been defined and accepted as mutually satisfactory by both prospective consumers and providers in the program, oral health care systems for the elderly can be devised on a more solid footing. Programs could then be planned with due consideration for the priorities to be placed upon component strategies: for providing crisis-oriented treatments, elective services, preventive measures, self-care training and education, wellness-maintenance, population-monitoring and health promotion, for example.

Related to goal-setting, ways must be refined for determining the "real" demand for oral health care and services at appropriate intervals, and for examining the resultant determinations by priority [illegible] national interest. Generally, priorities might be ordered along a spectrum, from relief of critical emergency (pain, infection, malignancy) at one end to satisfaction of personal desires at the other. The spectrum might be stratified simply in several ways to facilitate policy development and planning; once such priority stratification for dental concerns might consist of:

1. Medical or emotional urgency.
2. Improvement of sub-optimal oro-dental function.
3. Improvement of the quality of life.

In this example, the array moves also from serious oral problems on which "professional judgment need" and "patient-perceived need" are likely to be close, if not identical, to problems which are of high subjective importance to the patient but which the profession considers non-critical and society considers to be in the domain of personal preference and individual fiscal responsibility. As we extend our definition of "healthy" to cover more of the emotionally and socially important needs of the individual, these divergencies may be expected to narrow and, in the ultimate ideal, to coincide.

These and similar questions must be investigated and considered in determining the magnitude, the scope and the extent-limits of any health problem which rises to the level of a national concern. It is sharply evident that, for the planning of programs, the assessment of needs for dental interventions must be coupled with careful exploration of psycho-social needs of the elderly in order to arrive at clear guidelines on the distinctions between need and demand for dental services.

4. Personal Economics and Perception of Oral Health. Economic considerations, central to all health programs, are especially difficult to evaluate with respect to oral health which, like mental health, is still regarded as an area in which aberrations or diseases are seldom serious and rarely life-threatening. As a result, the economic priority on oral health care--and particularly where preventive or interceptive procedures

may be recommended to avert an impending crisis that is not yet perceived as threatening to the individual--too often is set at a relatively low level. This occurs in personal and family prioritization, as well as in community and governmental economics. In the case of the elderly, however, the combination of fixed incomes, rapidly deflating savings and other reserves, dwindling job prospects and the fear of worsening economic conditions in the near future depresses further the economic priority of things perceived as non-vital to survival. As a result, the contribution to be anticipated from private-sector financing of dental care for older people may not parallel the levels of private contribution experienced with medical care programs.

5. Implications for Manpower and Program Development. The implications of deficiencies outlined in this brief preliminary overview are serious. The speed and effectiveness with which we can improve the oral health care of the elderly and develop the proper manpower resources for the task depends heavily on how quickly and thoroughly we can produce and apply the missing definitive information in each of the foregoing areas. Each of these factors could have a very costly impact upon designing and developing a delivery system and subsystems if the basic information about the component factor is inadequate or otherwise misleading. The continuation of ad hoc, empirical, trial-and-error approaches is likely to waste much time, for they often create additional costly problems as effort is expended to correct course after the voyage into the darkness has once begun.

It may be fairly obvious that each of the foregoing issues, and many of their ramifications, has been dealt with before by policy-shapers and by program-implementing institutions, in one way or another. It should be equally obvious, however, that apparently they have not yet successfully been dealt with in a way that might fit them together into an effective, systematic plan for action on the total problem.

Admittedly, the oral health problem is complex and its total solution lies beyond the scope and the ability of any single government agency or professional or private organization to deal with it in its manifold entirety. The initiatives taken up to now, --in research, in manpower training, in professional education and in the inclusion of some dental services within certain programs of health care for the elderly--all are commendable, for it is important to do what can be done within existing frameworks until more effective frameworks are developed for the larger, coordinated attempt. But there are serious deficiencies in our knowledge of the extent and scope of needs and demands, in our understanding of the problems of raising public appreciation of oral health status, in our ability to assess the priorities for strategic planning of a long-range oral health program, and in the information from which we must make decisions on allocation of our economic and human resources; and we ought now to accelerate research efforts in these areas. All signs point strongly to the urgency of reassessing the fragmented approach of the past and undertaking intensive development of the necessary information-collection projects, health status definitions and criteria for goal-setting and evaluation; and of a rational, coordinated overall strategy for proceeding with the implementation of a holistic policy, in which the delivery of health care and the training of manpower will certainly be two important components--but only components.

While the traditional national tendency to focus almost exclusively upon the delivery of care is beneficial to those who are suffering distress because of failures in in the chain of health-preservation, it distracts attention from the essential challenges of examining the basic biological, social and economic causes of such failures, of arresting the whole problem at its fundamental sources. It is significant that the excellent analytical review by Bauer et al[3], was commissioned to try to find out what keeps people from utilizing the health care delivery system, with little emphasis on what more can be done to keep them from having to use it. Emphasis upon the delivery of care and the production of manpower should no longer be permitted to obscure our greater responsibility for coming to grips with the management of the whole problem as a multi-faceted entity.

Projections of the growth curve for our elderly population indicate clearly that the provision and preservation of oral health in the rapidly growing elderly population is a challenge of immense size, scope and extent. We face a future in which the traditional patchwork of stop-gap programs will not be sufficient. The challenge demands not only broad and far-sighted vision but the courage, the wisdom, the unity of purpose, and the enthusiasm to develop strong policy in oral health; and, most essential, the dual commitment, first to launch coordinated systematic programs of sufficient grandeur to match the challenge and then to support the entire system until the goals of the mission are attained.

The approach of the Canadians, for example, deserves concerted study. They are advocating policy development on the basis of the Health Field Concept, in which the control of each health problem is analyzed in light of four elements: Human Biology Environment, Life Style and Health Care Organization[4]. We have concentrated our efforts for the elderly on improving our Health Care Organization while the solutions to most of their oral health problems appear clearly to reside in changing the Life Style component, as discussed below.

II. PROBLEMS OF HEALTH AWARENESS IN ELDERLY POPULATIONS.

As with general problems of health, in all population segments, much of the crisis-related need for dental treatment and supporting services arises because too many people are not aware of the importance of oral health and the consequences of neglecting it.

But virtually all of the dental problems that appear in later life are preventable. Loss of teeth, dysfunction of the jaw-joints, impaired chewing function, flaccidity of oro-facial muscles, sagging and wrinkling of the lips and the face, loss of vertical dimension of the lower face,---these conditions, and the myriad lesser annoyances that accompany them, all result primarily from neglect of three dental diseases: tooth decay (dental caries), pyorrhea (periodontal disease) and misalignment of the teeth (malocclusion).

The first two can be prevented entirely by plaque-control through regular brushing, proper use of dental floss or toothpicks and, in resistant cases, restriction of dietary sugar. Once either disease begins, it can be totally arrested if professional treatment is secured early enough, and good health can be maintained by the practice of the hygienic procedures just described, coupled with annual or more frequent monitoring to check-up on the efficiency of the self-care as well as on the continuing quiescence of the diseases. The third, malocclusion, usually requires professional intervention early in life, when the teeth and jaws are still growing into their destined relationships and aberrant structures can be guided relatively easily back into an anatomically and cosmetically desirable course; but corrective treatment can be successful even when begun in middle age.

After "the big three", cancer is [illegible]st important oral concern for older people. Although oral cancer today represents only about 6.5 percent of all new cancers detected, the case fatality rate for some of the oral lesions is relatively high: 68 percent of men with cancer of the tongue, for example, do not survive beyond five years after the lesion is detected[5]. We cannot yet prevent cancer but, again, we know that awareness and self-examination along with regular professional check-ups significantly increase the odds in favor of early detection and surgical or chemical treatment before the cancer has a chance to spread. Control of cancer, however, also requires high levels of popular awareness, personal recognition and individual self-evaluation to motivate the prompt seeking of professional attention.

For most people, dental problems in later life result usually from lifelong neglect, rooted in one or more of three main human factors: a) ignorance of hygienic measures, b) non-compliant behavior and c) ignorance of, or aversion toward, available remedies or services. Despite decades of public education about oral health and hygiene,--in schools, and in commercial and professional television advertising,--significant statistical evidence of the specific effective impact of education alone on the prevalence of these four oral diseases has not yet emerged. For the benefit of future members of the elderly population, studies should be encouraged to determine which of the foregoing three factors account for most of the neglect, and to devise improvements that will remove the obstacles or reduce them to relative insignificance in perpetuating the destruction.

These three problem factors, of course, are common to the total general health picture; but perhaps the oral health situation, confined to the oro-facial area and concerned with only three or four primary disease entities, would provide a simple model in which to work out basic awareness-promotion, compliance-promotion and action-promotion techniques that, with relatively minor adaptations, might be applied successfully to health-promotion problems in other areas of concern.

On the other hand, large numbers of people develop serious dental problems in later life even after a lifetime of acceptable oral health behavior. Often these problems appear to be the result of a different set of three factors: a) breakdown or "slippage" of specific hygiene behavior, b) general deterioration of affect and attitude as the individual becomes more aged and c), relatively rarely, deliberate or involuntary abandonment of acceptable oral health practices because of preclusion by medical or physical problems or by specific medical contra-indications. Hygienic habits and practices often decline as other concerns move into preeminence in the daily priority system; many people bathe, change clothing, eat, sleep or shave with less regularity as they grow older, and regular care of the mouth frequently falls by the wayside along with these practices. Some individuals, particularly after the children or close friends have left or after the death of a loved one, undergo a generalized state of depression in which affect and attitude deteriorate significantly. In that state, when few things really seem to matter anymore, the individual's lifelong habits of behavior, including oral hygiene, often are diminished to the point of ineffectuality, or are abandoned altogether. In yet others, physical or functional impairment resulting from any of a wide variety of causes--from arthritis to stroke to mental confusion--makes it difficult, painful or simply impossible to continue routine hygienic procedures. In these people, oral health may break down as readily as the health of other physiological systems, and serious problems can quickly ensue.

The implications of these issues for the future dental welfare of the elderly are fairly obvious: successful prevention of oral disease throughout life would virtually eliminate the dental care problem in older age. More intensive research efforts in a) consumer education, b) motivation, c) compliance behavior, d) gerontologic psychology and e) sociology, combined with special emphasis on facilitating oral self-care habits in the physically and physiologically impaired, should certainly hold great promise in terms of keeping more people from having to enter the dental care delivery system in demand of costly remedial treatment.

III. PROBLEMS OF DENTAL HEALTH ECONOMICS.

1. Economics. The introduction alluded to the special posture of economics in oral health. Reliable and more extensive information is needed on the dental care-seeking behavior of elderly peoples, by so[illegible] strata, belief-systems, value-systems, and a self-esteem or self-activation c[illegible] some kind--yet to be developed.

It appears necessary also to get valid information about where the "price" of remedial dental services stands in the personal economy of the elderly: not just the dollar price but also the price in terms of declining resources of personal energy and drive, in addition to the emotional cost of such restrictions as fixed income in a rapidly inflating national economy.

Economic considerations also include questions of the availability, accessibility and acceptability of services to the elderly. It is not proven that, where dentists are in short supply (as in remote or sparsely settled regions), the plight of the elderly is any worse than that of younger people. Where dental services are abundantly available, however, they are not necessarily available equally to older people, for a number of reasons: older people often are perceived as less pleasant to work on, or more troublesome to satisfy after the work has been completed; payment for care is not as attractive because third-party payment procedures are sometimes more sluggish or irregular; or the provider may simply prefer to work on younger people as a matter of personal choice. Generally, however, these objections are being diminished as the dental professional community rapidly becomes more keenly sensitive to the needs and the problems of the elderly; further encouragement of the profession, through education and training activities including opportunities for direct experience with the elderly, should enhance the availability of service for the aging in all parts of the country.

The accessibility of services often is limited seriously by many factors, reviewed previously. The most important obstacle to access, not merely for the indigent elderly, is the continuing denial of dental health benefits to the millions of Americans who are eligible to participate in the health benefits of the Medicare program: From the viewpoint of modern medicine and our enlightened perceptions of physical fitness and holistic health, a Social Security policy that excludes two major pandemic diseases and an entire organ system from a public program aimed at the preservation of good health in old age is patently absurd. The persistent exclusion of oral health benefits from Medicare is no longer a tenable policy on any rational ground except that of projected costs to the national budget. Astute political economists must be encouraged to apply their expertise to the early resolution of the fiscal aspects of these paradoxical incongruities of "unofficial" national purpose and policy.

The economics of accessibility must also include consideration of the cultural, geographic, physical, emotional and temporal barriers against entry into the system and utilization of its services. Many minority people, not just the elderly minority, refuse to go to a clinic or private office where cultural surroundings different from their own make them feel uncomfortably out of place and uneasy at a time when there should be reduced apprehension and a sincere feeling of trusting confidence between the patient and those who will attempt to help him. Language differences inhibit accessibility. Geographic factors are not limited to distance alone but more frequently involve such simple problems as crossing a busy street, or having to take unfamiliar bus routes by oneself. Physical access is a problem to the handicapped and to the cardiac patient and is sometimes an impossibility for the homebound or bedfast individual, unless the services are brought to the home, or to the bedside as some of the "portable dentistry" specialists are able to do. Emotional states often become more brittle in aging, and many things--such as being kept waiting too long, dissatisfaction with the attitude of the attending staff, minor failures in matching a preconceived expectation of how the work will be done or how it will look or feel when completed--become blown so much out of proportion that the patient refuses to return. Finally, temporal barriers interfere with access when the dentist's clinic hours do not correspond with the times when the elderly individual can arrange for personal transportation or for a companion, for example.

In like vein, the acceptability of services can be unsatisfactory to many people for a variety of personal, cultural or other reasons,--all of which may tend to be exaggerated in the case of older individuals with fewer options and less flexibility of adaptation. Acceptability of care can subtly affect the economic success or efficiency of the system, and it warrants considered attention in planning and in delivering the services.

2. Politics and Public Priorities. As noted, the most serious economic block against access to dental services is the con[illegible]usion of oral health benefits from government health assistance programs, or minimization of the dental component to essentially ineffectual levels. Current policies in Medicare and Medicaid are, of course, especially hard on the indigent elderly[6]. But beyond that, the negative posture displayed in these bellwether federal programs establishes national precedents of low priority for oral health care that pervade the thinking of policy-shapers across the country, and this makes it doubly difficult for proponents of oral health care to persuade local politicians and legislators to include dental care assistance in state, county or municipal health programs.

The tendency to exclude oral considerations, vis-à-vis the life-threatening health issues or those which are perceived as greater "drains" upon the resources of society, is stronger in times of general economic constraint. But the issues of social cost in terms of dollars, loss of productivity in the labor force and the actual withdrawal of dentally-depressed elderly men and women from the socially-productive mainstream may be more expensive to the nation than is presently realized or understood. Intensified socio-economic investigation of such issues appears to be an important prerequisite of rational policy-making and program evaluation.

The concern of the public about oral health for the elderly has not generally been aroused to the point of insistent demand for the inclusion of dental services in social welfare and security programs as a matter of course. Studies of the attitudes of the general public toward the needs of older age,--their own older age as well as the current over-65 contingent,--and moves to increase public support for health programs in their own future interest should include oral health considerations as an integral component.

3. Impact of Economics on Manpower Training and the Delivery of Care. Elucidation of many of the foregoing factors could significantly alter current perceptions of the appropriate courses to follow in evolving delivery systems and in the training of

manpower for various roles in those systems. All of these factors relate importantly to the magnitude of future demand for dental care and to the kinds of services that are likely to be in lesser or greater demand, at various phases of our progression toward the time when prevention and [illegible] maintenance will virtually eliminate the demand altogether. Such determinations will in turn simplify the task of estimating our needs for manpower in each successive phase.

The current trends in evolving specialized manpower are reviewed throughout this report, and a relevant array is displayed in Table II. In today's depressed economic conditions, when dental practices are showing signs of decreasing busyness, it is unpopular to advocate the delegation of duties to auxiliary personnel. Yet, the so-called "GAO recommendation"[7] advocates exactly that, as a more economical and efficient way of catching up on the backlog of unmet needs. The responses offered so far by organized dentistry have not demonstrated any serious flaws in the fundamental basis of the recommendation which could not be worked out in the course of experimentation. The IHS (Indian Health Service) Dental Assistant Program and the New Zealand Dental Nurse Program (now over 55 years old) demonstrate that quality need not be sacrificed to efficiency. ¶ In developing a new manpower structure for the care of elderly, the possibility of evolving a class of specially advanced "denturists" for additional services is one that should not be overlooked. Neighborhood health advocates, neighborhood health aides, community dental hygienists, dentists, geriatric dental specialists within visiting-nurse services and other categories of auxiliary must all be considered as possible extenders of the dentist's potential to cope with his responsibilities in spearheading the movement toward oral health for the elderly.

It would be remiss to close a discussion of the economics of dental health without asking whether dental fees themselves are reasonable in light of the current economy. Statistics on the relatively low annual increase in dental fees compared to other health services do not address the fundamental question of whether dentists have done all they can to reduce the price they must charge for their services in the first place. The Select Committee on Aging reported in 1976[8] that the cost of providing dentures (including associated procedures) ranged from $500 to $1000. Many dentists today are providing dentures for as little as $100 each. But the Committee cited Sexton Clinic in Florence, S.C. as one group which could provide a denture for only $50, plus surgery charges when required, at a quality level which, despite contrary opinions from local dentists, was considered professionally satisfactory. Regardless of the ensuing arguments, fee differences of this magnitude deserve exploration as models for possible cost-reduction with respect to many other dental treatment procedures--with due respect, of course, to quality assurance.

IV. PROBLEMS OF PROFESSIONAL DENTAL SERVICE TO THE ELDERLY.

1. The Dental Profession's Attitudes and Self-perceptions. Recent events indicate that the dental profession in America is awake to the needs of the elderly and concerned with helping to meet them. The profession appears to perceive itself as doing a good job along four lines of approach:

a) in meeting the prevailing actual demand for dental care; i.e., in serving those older people who actually come into the office or clinic already committed to the patient-role and actively demanding the service which they seek from the system;

b) in improving technological excellence with respect to prosthetic dentistry, oral physiology and arthrology and also in improving their appreciation as professionals of the behavioral management of the elderly;

c) in encouraging interest in geriatric dentistry and services for the elderly and handicapped; and

d) in promoting legislative, educational and social action aimed at improving the oral health status of the aging.

These directions are being pursued intensively by the American Dental Association through its ACCESS program and by numerous other specific involvements of the profession and the public in the dental concerns of the elderly. In addition, dentists, dental hygienists and dental educators and public health workers are active in many national and regional geriatric organizations as well as in specifically dental organizations like the American Society for Geriatric Dentistry. The National Foundation of Dentistry for the Handicapped operates several effective programs which are directed primarily toward serving the elderly population, in the community as well as in nursing homes.

Publications devoted to dental geriatrics are steadily increasing. Continuing education programs in the care of elderly patients are becoming more popular and also more numerous.

Much of the focus, however, is still on the more spectacular problems of the institutionalized, homebound or handicapped patients who, statistically, comprise only a few percent of the population over 65 years of age. As interest and sophistication rise, it may be expected that more members of the profession will become better attuned to the special concerns of older people wherever they encounter them.

2. Education. Some form of dental geriatric education was being provided in all 58 of the 62 dental schools responding to a survey conducted by Ettinger, et al during 1979. At seven of them, a formal course in geriatric dentistry was firmly established as an integral component of the undergraduate curriculum; and an organized series of lectures was taught at 17 others.[9] Moreover, the extramural outreach programs which are operated by many dental schools increasingly include experiences with the elderly, in nursing homes, congregate living centers or other locations. Some schools bring elderly patients into the school regularly for clinical care.

The National Institute of Dental Research (NIH) and the Division of Dental Health (HRA) are the only two specifically dental units in the United States government today. Both NIDR and DDH support research and training related to the aging but, in the absence of a categorical dental geriatric agency or sub-unit, coordinated emphasis is necessarily very limited. Although the National Institute on Aging is increasing its emphasis on oral factors, and the Aging Administration and other federal agencies are technically authorized to engage in oral health concerns, no critical mass of dental people has yet been established in any of them, and the federal focus on dental considerations which the NIDR and DDH provide in other areas is lacking for dental care of the elderly outside of those two units.

3. Advances in Technology. Technological advances in dental gerontology currently emerge primarily from the interests of individual dental practitioners, or of small and informal groups of dentists. Subsequently, innovations are developed empirically to meet the specific problem-interests of each such practitioner or group. While

these advances are highly commendable evidences of spontaneous professional dedication, commitment and ingenuity, their very spontaneity is a signal of what perhaps is their most glaring deficiency at this moment of the state-of-the-art as a whole. They are evolving randomly as individual, ad hoc responses to individual perceptions of various parts of the problem, and there is virtually no systematic collaborative effort nor evidence of any mission-oriented strategy or planning for the larger picture or for the long-range future. In Denver, for example, the NFDH provides a van filled with dental equipment which when wheeled into a nursing home or congregate living center is set up as a complete modern operatory, and is supported by dental laboratory capability built into the walls of the van itself. The van driver is a skilled and experienced dental assistant and laboratory technician. The entire system is made available to any dentist who wishes to use it for treating elderly or handicapped patients in their own locations, usually on a fee-for-service basis if not as a fee-waived contribution of the dentist to the community. Subsystems for case-finding, follow-up, recall or health maintenance, however, are not integrated into the system but are left to chance or to the individual preferences of the dentists who contract to use the van.

In a less complicated mode, the approach described by Shaver[10] (1975) is utilized by many dentists in various parts of the country: several kits of rotary equipment, instruments and supplies for specific kinds of dental services (restorative, prosthetic, surgical, etc.) are condensed into convenient suitcase-sized packages which may be transported by personal automobile to a nursing home or to a private residence and hand-carried either to the bedside or to a beauty-parlor or other available room in the facility where patients can then receive dental care of the same high quality as the dentist would provide in his own offices. Shaver (unpublished communication) has developed a system for recruitment, examination and recall of nursing home patients; but as yet there is no systematic long-term follow-up, health-monitoring, economic or psychological support service, or case-finding for individuals who do not voluntarily seek treatment or who cannot afford to pay even the reduced costs of the services.

4. Need for Developmental Research on Model Systems. Because the costs of remedial dental care in the elderly are so great, it is in the national interest to support

intensive study of methods for maintaining oral health and avoiding or at least significantly reducing the development of expensive oral health crises. One model system which is currently being readied for trial in the controlled environment of a long-term care facility for the elderly[11] is illustrated in Figure 1.,b. All residents are screened. Existing pathology is corrected by the dentist. The specialized Community Dental Hygienist then instructs in self-care and works with the patient, and with the Oral Health Aide assigned by the facility to monitor a large cohort of residents, until the proper self-care pattern and habit are established. The Oral Health Aide supervises the self-care and monitors for suspicious signs of disease, aberration or abnormality that require professional evaluation. The Community Dental Hygienist visits many facilities each week and the Oral Health Aide brings such cases to the Hygienist's attention at each visit. The Hygienist treats conditions within her professional jurisdiction and expertise and refers more complex situations for early evaluation by the dentist and subsequent correction of the pathological condition he may identify; whereupon the entire cycle starts afresh. In theory, this system should identify the earliest signs of aberration from the wellness-standard, facilitating the initiation of interceptive or corrective interventions while the aberrations are still minimal and before the development of a costly crisis situation. The system by-passes the processes of passive neglect which are the forerunners of all serious disease crises. The cost-effectiveness of the proposed system will be studied as part of its overall evaluation.

Extension of this closed-system model into the uncontrolled environment of the elderly who live independently in the open community will require the development and coordination of numerous support services, involving a broad spectrum of professional, paraprofessional and community resources, and a variety of manpower constellations.

V. DIRECTIONS FOR RESEARCH AND STUDY.

The foregoing review of the state-of-the-art in serving the dental needs of the elderly indicates that, for the stage immediately ahead, refinement of goals, consolidation of directions and coordination of efforts are of first concern. The review emphasizes also the importance of developing the supportive and coordinative sectors for the delivery systems, --large and small, --simultaneously with the health-professional and health-auxiliary components, and of cultivating their maturation along with the dental profession's training and interest. Dentists may be able to "do it themselves" but the empirical approaches demonstrated by dentistry up to now are not likely to keep pace with the burgeoning increases expected in the elderly population and the anticipated growth of their health awareness and consequent demands for more services, and for advice on prevention, self-help and health maintenance. Other dimensions of the problem of the special aged population who never get to a dental office were outlined in 1975 by Roeck and Bernhard[12]: a) inability to go for care, b) lack of funds, c) lack of understanding on the part of adult children or other custodians, d) physical or mental complications, e) failure of physicians to recognize dental needs.

Research and study should now be encouraged along broader lines, while the current programs in dental geriatric technology and manpower development continue to be sustained and enlarged for expanded effectiveness in the community.

The elements of a total system for providing comprehensive dental service, including self-care and maintenance, to the elderly may be organized conceptually into the oversimplified but illustrative classifications shown in Table II.

Figure 2 depicts an analytical matrix, based upon those elements, against which programs of dental health care delivery may be evaluated for their effectiveness in promoting health maintenance and thus reducing costly utilization of crisis-care. By examining whether each listed function is represented in a given program by a corresponding active (+) or a passive (-) component function, one can readily visualize the relative systematic completeness of the program and identify its specific deficiencies. Programs of health insurance or others which furnish only economic support are seen as the weakest and, accordingly, the least cost-effective in the long run.

National efforts directed toward long-range maintenance of good oral health rather than toward corrective care and treatment will provide the best results for the elderly at the lowest eventual cost. The Health Promotion Organization (HPO) concept, elaborated by Ng, Davis and Manderscheid[13] appears to be almost ideally adaptable to the limited arena of oral health in the circumscribed population of the elderly. A whole new line of research endeavor may be opened in pursuit of HPO development and testing on this model problem.

VI. SUMMARY: DIRECTIONS FOR THE FUTURE

1. Clearly defined national health status goals and firmly expressed national health policy comitments are necessary on oral health issues, as primary foci toward which all concerned components of American society can direct their dedication and their resources. Clear national comitments will serve to unify and harmonize the activities of the dental profession, the total health community, biomedical science, governments and the people of America, --including not only the aging population but those who prudently are preparing to become a part of it.

2. The health professions, in partnership with governments, must provide the leadership, the imagination, the dollars and the initial coordinative expertise for encouraging sophisticated, sound systems development, and for outlining the frameworks for it. No longer can oral health considerations be omitted from important national and regional planning and implementation, nor relegated to token levels of priority as if oral health were something severable from the concept of human health as a whole.

3. Incentives and efforts must be stimulated in basic, developmental and applied research and technology, focussed more heavily upon health promotion and maintenance and on reducing the necessity of utilizing the costly services which are required for managing the crisis conditions that develop as a result of neglect in the four main diseases of the mouth: tooth decay, periodontal disease, malocclusion and cancer.

At the same time, research must continue to focus upon more effective means of preventing and controlling oral disease and improving the effectiveness of deliverying care and related services that are needed immediately by the elderly. With judicious division of emphasis, both phases of research can and must be pursued simultaneously.

4. Extensive field trials and demonstrations of new systems of health care delivery and health promotion must be supported and encouraged. The Health Promotion Organization concept deserves special attention as a potentially useful starting-point for system-planning.

5. Manpower development must be intensified in the whole professional community which is primarily responsible for the oral health of the elderly: dentists, dental hygienists and paradental auxiliaries including new kinds of geriatric paraprofessionals; and research investigators. In addition, however, the scope of dental manpower development must be extended actively into other related professions and disciplines: medicine, nursing, sociology, social work, economics, political science, health administration, health education and systems development and management. With such extension, the comprehensive interdisciplinary systems required to bring oral health problems of the elderly under rational control could be evolved, elaborated and tested in the relatively near future, utilizing manpower as it comes out of the training pipelines instead of having to develop necessary personnel ad hoc.

6. Special attention must be directed to research on means and methods for fueling the dental health care delivery systems of today and the future with adequate money to produce and pay for the necessary care and, more important, for the cost-reducing services like preventive intervention, education, self-care and wellness promotion, monitoring and early detection, and health maintenance.

7. Of immediate importance at the present moment is the urgency of integrating strong oral health components into all existing and emerging health programs, social programs and economic assistance programs that deal with the health and welfare of the elderly. The sooner the significance of oral health begins to pervade the thinking of the entire community of all people who are involved with securing the future of our aging populations, the sooner will the enormous problems of dental disability and their consequences for the quality of life be reduced to manageable challenges which small groups of people, working together, can readily resolve independently at the level of the smallest community as well as on the national scale.

TABLE I

SOME ESTIMATES OF CURRENT DENTAL CARE NEEDS OF THE ELDERLY IN THE UNITED STATES

	Number	Percent
Estimated total U.S. population, 1979	220,099,000[a]	---
Estimated number aged 65 and over	24,658,000[a]	100.0
Number of edentulous persons	12,501,606	50.7[b]
Number with one arch edentulous	4,259,397	17.2[b]
Number needing one or more dental treatments	15,041,380	61.0[c]
Removal of debris and calculus	2,071,272	8.4
Gingivitis treatment	863,030	3.5
Periodontal disease treatment	3,797,332	15.4
Decay treatment	4,413,782	17.9
Extractions, for any reason	2,416,484	9.8
Fixed bridge or partial denture	2,095,930	8.5
Repair of denture or bridge	1,898,666	7.7
Construction of full denture	6,115,184	24.8
		[96.0[d]]
Total Treatments Needed	58,604,740[e]	
Average number of treatments per person needing care		3.90
Average number of treatments needed per person aged 65 years and over		2.38

---

a. United States Bureau of the Census: 1979 Population Estimates

b. Estimate of age-adjusted rate for persons aged 65 and over, calculated from National Center for Health Statistics: *Basic Data on Dental Examination Findings of Persons 1-74 Years, United States 1971-1974*, DHEW Publication (PHS) 79-1662, Series 11, No. 214, Table 1; and from data supplied by Dr. Tulio Albertini, Division of Dentistry, DHHS, 1980.

c. NCHS op. cit.: All ratios taken unadjusted from Table 2, cohort 65-74.

d. Original figures (in reference c.) do not total 100 percent.

e. Note that the Total Treatments Needed figure reflects the multiple needs of many people in the 15.4 million who needed at least one treatment.

COMPREHENSIVE DENTAL SERVICES TO THE ELDERLY

1. Clinical System and Subsystems

Objective: to establish and maintain satisfactory levels of clinical oral health.

a) Dentists with expertise in the care of the elderly
b) Geriatric Dental Hygienists
c) Geriatric Dental Assistants[1]
d) Geriatric Oral Health Aides[1]
e) Dental Laboratory Technicians[2]
f) Clinical Dental Technologists[2]
g) Technology and research support for each service level

2. Social and Economic Support Systems

Objective: to enable and facilitate utilization of the clinical systems and the self-care and health-maintenance systems.

a) Case-finding systems, with awareness and health-promotion components
b) Access and entry systems, providing "active capture" mechanisms as well as convenience of access, with special attention on
    i) social or emotional barriers
    ii) economic barriers
    iii) physical or geographic barriers,

and on the problems of the incapacitated or "special needs" elderly.

3. Coordination Systems and Subsystems

Objective: to establish and maintain functional relationships within and between the clinical and support systems at levels of efficiency that will maintain optimal conditions of health and wellness, in accordance with criteria defined in the mission and goals of the program.

a) Medical-dental coordination[3]
b) General systems coordination[4]:
    i) Coordinated planning
    ii) Coordinated operation
    iii) Coordinated evaluation and feedback.

---

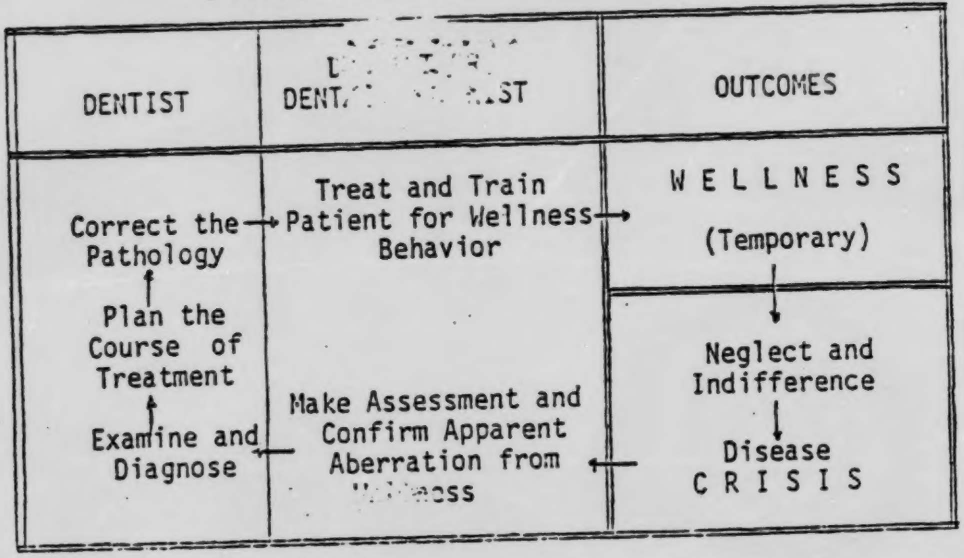
[1] A new category of auxiliary, for service in community settings, long-term care facilities, private dental offices, etc.

[2] Recognizing the message of the "denturist" movement as a response to a serious social problem, many states are now encouraging laboratory technicians to assume more responsibility for meeting the public demand for dentures, under the quality-control of the dental profession and regulated by law.

[3] E.g., routine referral for oral assessment; medical back-up by physicians who recognize the importance of the mouth in the elderly and can function as part of the comprehensive health care team.

[4] These three functions to be integrated between all subsystems as well as within each system and subsystem.

-: PROBLEM-ORIENTED SERVICE CYCLE :-


DENTIST
[illegible]
OUTCOMES
Correct the Pathology
Plan the Course of Treatment
Examine and Diagnose
Treat and Train Patient for Wellness Behavior
Make Assessment and Confirm Apparent Aberration from Wellness
WELLNESS
(Temporary)
Neglect and Indifference
Disease
CRISIS

-: WELLNESS-ORIENTED SERVICE CYCLE :-

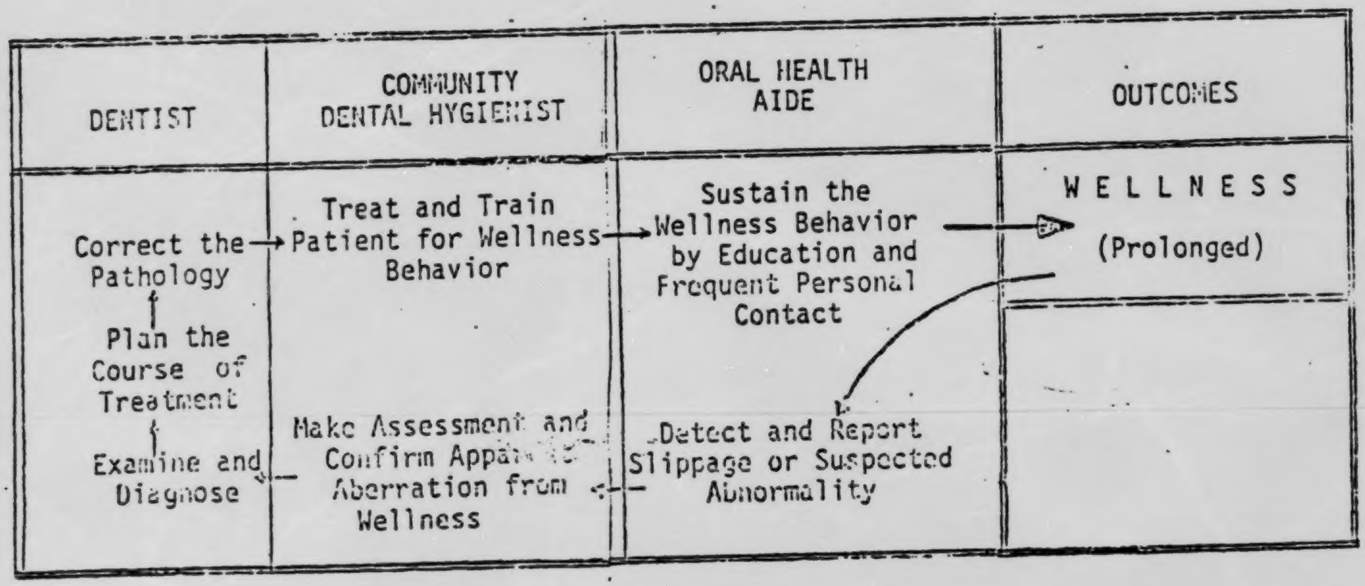

DENTIST
COMMUNITY DENTAL HYGIENIST
ORAL HEALTH AIDE
OUTCOMES
Correct the Pathology
Plan the Course of Treatment
Examine and Diagnose
Treat and Train Patient for Wellness Behavior
Make Assessment and Confirm Apparent Aberration from Wellness
Sustain the Wellness Behavior by Education and Frequent Personal Contact
Detect and Report Slippage or Suspected Abnormality
WELLNESS
(Prolonged)

Figure 1. Two Dental Service Systems for the Elderly Residing in Institutions or in the Open Community: a) Problem-oriented cycle; b) Wellness-oriented cycle.

Figure 2.

COMPREHENSIVE HEALTH MAINTENANCE SYSTEM CHARACTERISTICS

PROGRAM, FACILITY OR SERVICE	A. CLINICAL SYSTEM						B. SUPPORT SYSTEM					C. COORDINATION					NOTES OR DESCRIPTION
	1. Clinical crisis-care	2. Follow-up	3. Patient Instruction	4. Home/Self Maintenance and Prevention	5. Monitoring and Supervision	6. Centralized coordination	1. Case-finding	2. Access and Entry a) Social/Emotional	b) Economic	c) Physical/Geographic	d) General Health Problems	1. Administrative or Family Support or Assistance	2. Central Clinical Coordination	3. Central Support Coordination	4. Partial Coordination between Clinical & Support Systems	5. Full Coordination between Clinical & Support Systems	
Medicaid; or Colorado Old Age Pension Progr.	+	-	±	-	-	-	-	-	+	-	-	+	-	-	-	-	Provides funds for selected dental services
Nat. Fdn. of [illegible] for Hdcpd: Mobil[illegible]	+	-	±	-	-	±	±	-	±	+	-	+	-	+	+	-	Portable dental office equipment and laboratory
Metro Denver Dental Society: HELP Program	±	-	-	-	-	-	±	-	-	-	±	+	-	-	-	-	Referral list of dentists with interest and reduced fees for needy
Neighborhood Health Program	+	±	+	±	-	+	-	+	+	±	+	+	+	+	±	-	Dental clinics for eligible clients
Migrant Health Program	+	±	±	±	-	±	±	+	+	+	+	+	±	+	±	-	Health care for eligible migrant workers
Jewish Family & Children's Service: "HIPE"	+	+	+	±	±	±	+	+	±	+	+	+	±	+	+	-	Health Intervention Program for the Elderly: home visit, exam & referral
Periodic visiting dentist at LTC facility	+	±	+	±	+	-	±	±	±	+	+	±	-	±	+	-	Oral Health Aide organizes & monitors patients of the dentist
LTC facility wthout Oral Health Aide	+	-	±	-	-	-	±	-	±	±	+	±	-	-	-	-	Dentist visits when called; or receives patient in his private office

+ = Active; or positively pursued

- = Passive; up to patient's initiative; or not available

± = Pursuit is not integral part of system; partial or occasional pursuit; or function not fully operational

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OSTEOPOROSIS

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I. INTRODUCTION

Although osteoporosis is a major cause of disability in the U.S., it has received relatively little attention from health professionals. One reason for this is that the disorder is so poorly understood and its clinical expression so variable. Osteoporosis can be defined as a proportional decrease in the amount of both bone mineral and matrix, in a given volume of skeletal tissue. Clinically we use the term "osteoporosis" in a number of conditions in which there is a reduced bone mass resulting in defective skeletal function.

Age-related bone loss is a universal phenomenon. Many older individuals who have an unusually low bone mass initially or lose bone faster with age will develop clinically apparent osteoporosis with skeletal fractures, deformities, and pain. The occurrence of fractures also depends on an element of chance, since some trauma is usually involved. It would be useful to be able to determine which individuals are most likely to develop symptoms so that we could institute treatment before they occur. Of the many factors which predispose to osteoporosis, one of the most important is the occurrence of rapid bone loss at the menopause related to a decrease in sex hormone production. Moreover women have a smaller initial bone mass th n men. Hence osteoporosis is most common in post-menopausal women, although it does occur in older men.

Other bone diseases occur with increased frequency in the elderly, including osteomalacia, in which bone mineralization is impaired, and primary hyperparathyroidism and malignancy involving the skeleton, in which there is increased bone destruction. There are less common forms of osteoporosis which occur in younger individuals, in which glucocorticoid excess, alcoholism, liver disease and immobilization may be contributing factors. We do not know the cause of osteoporosis in post-menopausal women and older men and the disorder may represent a heterogenous group of metabolic bone diseases.

There is at present no established treatment for osteoporosis and it is likely that the most fruitful approach in the immediate future will be to develop better preventive measure If we can identify those individuals who are most at risk for developing clinical osteoporosis their bone loss can be minimized or delayed by administering sex hormones and by increasing calcium intake. Exercise and vitamin D supplementation may also be useful. Once symptomatic osteoporosis has developed, a number of other agents have been used including calcitonin, fluoride, parathyroid hormone, vitamin D metabolites, phosphate and growth hormone. However, there are no controlled clinical trials which demonstrate that these measures are effective in reversing established osteoporosis.

One impediment to progress is our limited ability to assess the structural integrity and functional state of the skeleton. Bone density and calcium content can be measured and bone biopsies can be used to assess bone mass and cellular function but these procedures are limited in application. There are no convenient chemical methods to measure the rate of bone breakdown or repair in a given individual and no method for assessing skeletal strength rather than mass.

In this paper I will 1) provide a brief overview of bone metabolism and regulation, 2) summarize what is known about the pathogenesis, prevention and treatment of osteoporosis, and 3) point out some of the major gaps in our knowledge. References will be largely limited to recent studies. A number of texts and reviews can provide additional references and more detailed information on bone metabolism and disease (1-4).

II. THE STRUCTURE AND FUNCTION OF THE SKELETON

The mammalian skeleton serves two different and often incompatible functions. It must be strong, light, mobile and capable of repair and remodelling in response to changing stress. It must also serve as the metabolic reservoir for most of the calcium and phosphorus in the body as well as substantial amounts of magnesium, sodium and carbonate. The initial modeling of the skeleton during fetal life is determined largely by formation of bone on cartilage templates. Thereafter, bone grows by a number of different processes. In cortical bone there is deposition on the outer or periosteal surface and removal or resorption on the inner or endosteal surface. To add strength to this outer structure there is a spongy network of trabecular bone inside the shaft. In long bones most of the trabecular bone is at the ends where the shape and patterns of stress are complex.

The vertebrae and flat bones of the skull, pelvis and shoulder girdle consist largely of trabecular bone with a relatively thin cortex.

Bone undergoes continuous remodelling. In the cortex this is predominantly Haversian remodelling, in which vessels penetrate the bone and a resorption canal is formed and filled with a new osteon consisting of lamellar cylinders of new bone oriented to provide maximal strength. Trabecular bone undergoes surface remodelling in which osteoclasts resorb scalloped areas of bone called Howship's lacunae and these are filled with new lamellar bone. Hence, once the skeleton is formed, further new bone formation occurs largely at sites of previous bone resorption, in packets which are called bone remodelling units (5,6). We use the term coupling to describe the close anatomical and temporal link between resorption and formation. The mechanisms which control the rates of remodelling, the coupling of formation to resorption and the size of the bone remodelling units are largely unknown.

As part of its storage function the skeleton provides calcium and phosphorus when the supply of these elements is deficient. The sodium and carbonate of bone as well as the phosphate can also buffer excesses of acid in the diet. These responses preempt the structural functions so that growth and remodeling are impaired and skeletal mass may decrease in calcium or phosphorus deficiency or chronic acidosis.

The movements of calcium and phosphorus are controlled by three calcium regulating hormones. Parathyroid hormone (PTH) maintains serum calcium concentration by stimulating bone resorption, by increasing reabsorption of filtered calcium in the kidney and indirectly by increasing vitamin D activation which in turn increases calcium absorption in the intestine. PTH has an additional important action in the kidney to decrease tubular reabsorption and hence increase excretion of phosphate. This decreases the serum phosphate concentration and helps to maintain the serum calcium concentration by limiting redeposition of calcium and phosphate back into the bone. PTH can also decrease bone collagen synthesis which would limit bone formation and help keep calcium in the circulation. However, this effect is often overwhelmed by a coupled increase in bone formation secondary to increased resorption.

Vitamin D is really not a vitamin but a hormone which can be synthesized in the body. It was called a vitamin because oral supplements were used in treating individuals who did not form enough vitamin D in their skin because of inadequate exposure to sunlight. Vitamin D is synthesized and activated in three steps. In the skin 7-dehydro-cholesterol is converted to vitamin D_3 or cholecalciferol. In the liver this is hydroxylated to 25 OH vitamin D or calcifediol. A second hydroxylation occurs in the kidney to 1,25-dihydroxyvitamin D or calcitriol which is the final active product of the vitamin D hormone system. The major effect of calcitriol is to increase the intestinal absorption of calcium and phosphorus and maintain the supply of these ions for bone mineralization. Thus, it is an essential hormone for bone growth. However, when the dietary supply of calcium and phosphrous are inadequate calcitriol can act on the skeleton to increase bone resorption and mobilize calcium and phosphate for remodelling and fracture healing even in the absence of a dietary supply. Under these conditions calcitriol does not act as a growth hormone, but may slow skeletal growth.

Calcitonin is an anti-hypercalcemic hormone. It reduces serum calcium concentration by inhibiting bone resorption. This effect is important in preventing hypercalcemia in rapidly growing animals who can ingest large amounts of calcium and absorb it rapidly. When the serum calcium concentration increases calcitonin secretion is stimulated. This response reduces bone resorption so that movement of calcium from bone to blood is temporarily stopped. Thus, calcium can enter from the intestine without causing excessive hypercalcemia and loss of calcium in the urine.

The physiologic importance of PTH and calcitriol is demonstrated by the fact that excess or deficiency of either hormone has marked effects on calcium regulation and bone metabolism. Curiously excess or deficiency of calcitonin has no marked effect on these functions in adult humans, although subtle abnormalities may occur. Changes in all three hormones occur with age and could play an important role in age-related bone loss and in the development of osteoporosis. The concentration of PTH measured by an immunoassay increases with age (7) while the concentration of calcitriol tends to decrease (8). Both of these changes may be due to the decrease in renal function which occurs with aging since the kidney synthesizes calcitriol and metabolizes and excretes PTH. The concentration of calcitonin may also decrease with age, and the secretory response to a rise in serum calcium is markedly diminished (9) especially in women.

Many other hormones affect bone metabolism and could be important in age-related bone loss. A decrease in sex hormone levels may be responsible for accelerated bone resorption (10,11). This is most apparent in post-menopausal women in which estrogen levels decrease rapidly, but may also be related to decreased androgen and progestin levels (12). Although bone resorption changes in vivo, it has not been possible to show any direct effect of sex hormones on bone resorption in vitro at physiologic concentrations (13). Hence it seems likely that the effects of sex hormones are indirect (see below).

Thyroxin is necessary for bone growth and turnover. Thyroid hormones can stimulate bone resorption directly (14) and this may be the reason for increased bone turnover and loss of skeletal mass, particularly in older individuals with hyperthyroidism.

Adrenal glucocorticoids have multiple direct and indirect effects on the skeleton (15,16). Probably the most important effect is inhibition of bone cell proliferation (17,18) which can result in impaired skeletal growth in children and contribute to osteoporosis in adults. Glucocorticoids may also decrease intestinal absorption of calcium and increase bone resorption.

Insulin is an important trophic hormone for bone as it is for many other tissues. In vitro it is a selective stimulator of osteoblastic collagen synthesis (19). While the incidence of clinical osteoporosis is not clearly increased in diabetics, impaired growth and diminished bone mass can be seen with insulin deficiency (20,21).

Growth hormone clearly stimulates skeletal growth both in children and adults (22). Before puberty the major effect is on cartilage growth while after puberty, when the epiphyses are closed, both bone and soft tissue growth are stimulated. The effect is probably not direct, but mediated through increased production of somatomedins by the liver.

The somatomedins, or insulin-like growth factors, differ from insulin in that they stimulate both collagen synthesis and cell replication in vitro (23). Recently it was found that fetal or embryonic bone itself can produce factors which stimulate its own growth (24).

There must be local factors which influence bone remodelling. Bone is known to remodel in response to stress which may act by generating small electrical currents in bone, the so-called piezo-electric effect (25). In man small currents generated by direct insertion of electrodes or by placing magnetic field around the bone can increase skeletal growth and produce healing of previously ununited fractures.

Local effects could also be mediated by local hormones. Prostaglandins are produced by bone and can stimulate bone cell replication as well as bone resorption (26,27). Another potential local mediator is osteoclast activating factor (OAF) (28). OAF is produced by activated human lymphocytes and also by malignant lymphoid cells. There is evidence that OAF is a mediator of bone destruction in multiple myeloma and other hematologic neoplasms (29), but its physiologic role is unknown. Since it is produced by cells which are found in the bone marrow, it could be involved in the increased endosteal bone resorption which is characteristic of age-related bone loss.

Several cell types are targets for those hormones which act on bone. The osteoblasts are the major bone forming cells while the osteoclasts are the major bone resorbing cells. Chondrocytes form cartilage and their growth determines skeletal size and shape. The osteocytes are former osteoblasts which have become embedded in their own matrix. Little is known concerning their metabolic function. Bone also contains mesenchymal cells, fibroblasts, marrow cells, macrophages and mast cells which may be precursors for or interact with the major bone forming and resorbing cells.

The osteoclast is a multinucleated cell which attaches to bone by a clear zone which surrounds a ruffled border; the size of active resorption (30). These cells are probably derived from a different cell line from the osteoblast; perhaps cells of the monocyte-macrophage series. We do not know exactly how osteoclasts resorb bone. They are capable of removing both mineral and matrix, and appear to be able to synthesize and secrete large amount of lysosomal enzymes (31). They remove calcium from bone by a mechanism which may involve secretion of hydrogen ions or organic acids.

The osteoblasts are also highly differentiated cells. They synthesize and secrete collagen as well as other noncollagen components of the bone matrix or osteoid and can also produce matrix vesicles which may initiate mineralization (32). New osteoid does not mineralize for several days during which chemical changes such as collagen cross-linking occur in the matrix. An adequate supply of calcium and phosphate is necessary for mineralization and large amounts of unmineralized matrix are formed when the supply of these ions is inadequate. This accumulation of unmineralized osteoid is most commonly due to a deficiency or impaired activation of vitamin D which results in the bone disease called osteomalacia in adults and rickets in children.

Most hormones which influence skeletal metabolism affect both osteoclasts and osteoblasts. For example, the most important stimulators of osteoclastic bone resorption, PTH, calcitriol, OAF, and prostaglandin E_2, can also inhibit osteoblastic collagen synthesis (33,34). Glucocorticoids appear to have no inhibitory effect on differentiated osteoblasts and osteoclasts, but markedly inhibit the proliferation of the precursors of both cell types. Insulin and the somatomedins have been shown to stimulate osteoblasts, as well as chondrocytes, but have no effect on osteoclasts. Calcitonin is a selective inhibitor of osteoclasts with little effect on bone forming cells (34).

III. OSTEOPOROSIS

1. Clinical Features

a. Post-menopausal osteoporosis

The most common form of osteoporosis is that encountered in post-menopausal women. The diagnosis is often first made by the radiologist, but this may be inappropriate, since the finding of decreased bone density is nonspecific and routine radiographs are a relatively insensitive means of detecting this change. In some patients there are no symptoms, but there is usually loss of height with increased kyphosis of the dorsal spine. Radiologically the vertebrae show decreased density, loss of height relative to width, and an increase in the size of the vertebral space, particularly (Schmorl's nodes or codfish vertebrae). A relatively small proportion of patients develop the full crush fracture syndrome with wedging of the vertebral body and disruption of the cortex. Compression fractures of the vertebrae are usually painful, although the severity is quite variable. Fractures of the distal radius and femoral neck, often associated with minimal trauma may be more common than vertebral fractures in patients with osteoporosis. Although there is some overlap, the patients who develop vertebral and wrist fractures are likely to show greater loss of trabecular bone while those with hip fractures show more cortical bone loss (35). In the crush fracture syndrome bone loss may be confined to the axial skeleton, while the long bones of appendicular skeleton show normal density (35). Epidemiologic studies show a marked increase in the incidence of hip fractures in women aged 90 compared to women aged 30 (36). Most of this increase occurs after age 70. It can be estimated that the cost of acute care of hip fractures alone in the U.S. is over 800 million dollars/year (37) and 12-20% of elderly patients die within 6 months after such a fracture (38). It is less easy to estimate the cost of vertebral compression fractures in terms of morbidity, mortality, and expenditures for medical care, but this syndrome is a major cause of pain and limitation of activity in post-menopausal women.

The clinical course of vertebral osteoporosis is often episodic. Patients develop one or more crush fractures with severe pain which lasts for several weeks but then decreases. Some patients continue to have chronic back pain pain while others become symptom free. Recurrent episodes of vertebral fracture lead to progressive loss of height and increasing deformity. Ultimately the ribs come to rest on the iliac crest of the pelvis. Not only does this produce discomfort by itself but many patients develop gastrointestinal symptoms due to compression of the abdominal organs. The severe kyphosis probably has adverse effects on cardiovascular and respiratory function although these have not been carefully studied. The chronic pain and the fear or further fractures leads many patients to avoid activity and impairs their function in society. Moreover, immobilization can further accelerate bone loss.

b. other forms of osteoporosis.

So-called senile osteoporosis in men is clinically indistinguishable from postmenopausal osteoporosis in women except that it occurs less frequently and rarely develops before age 75, while in women symptoms often develop in the 50s or 60s (39). There are also rare forms of osteoporosis which develop earlier in life. Juvenile osteoporosis is a syndrome which develops at puberty and may result in fractures, deformity, and bone pain, but appears to be self-limited with spontaneous improvement in symptoms and bone mass after several years (40). Idiopathic osteoporosis is a term used when patients develop severe bone loss with multiple fractures in their 30s and 40s with no apparent cause. Other forms of osteoporosis in which there is evidence for a specific pathogenetic factor are discussed below.

2. Pathogenesis

We know little about the pathogenesis of osteoporosis. Most data suggest that the primary abnormality is an acceleration of bone resorption. Kinetic studies using labeled calcium show increased bone resorption with a lesser increase in bone mineral apposition (41) and morphologic studies show an increase in bone resorbing surface (42). Fasting urinary hydroxyproline, which reflects the breakdown of bone collagen, and fasting calcium excretion which reflects mineral loss, are both increased in osteoporotic patients (43,44). Serum alkaline phosphatase, which reflects osteoblastic activity, is slightly increased in osteoporosis (45) suggesting that there is no absolute decrease in bone formation rates. However, it seems unlikely that accelerated bone resorption is solely responsible for the decrease in bone mass. In younger individuals the accelerated bone resorption which occurs during normal growth and in thyrotoxicosis and hyperparathyroidism usually does not cause a loss of bone mass because there is a proportionate increase in coupled bone formation. Thus, even an elevated absolute bone formation rate may be considered inappropriately low if the patient is losing bone mass. Moreover, morphologic studies indicate that there is a decrease in the size of bone remodelling units, suggesting that the amount of coupled bone formation in response to bone resorption is decreased (46). There may be considerable heterogenity in pathogenesis among patients with osteoporosis. Bone biopsies show increased osteoclastic activity in some patients, while in others the bone surfaces are relatively inactive (47). This finding has led to the concept that these are two different types of osteoporosis characterized by high and low bone turnover. However, these different forms could represent different stages of the same disease.

No marked abnormality of the calcium regulating hormones has been demonstrated in osteoporosis. While there is a slightly lower concentration of calcitriol in osteoporotic patients compared to age-matched controls, control subjects who are a decade older have even lower calcitriol levels (8). There is no consistent difference in immunoreactive PTH levels in osteoporotic patients although subgroups with relatively high or relatively low values of PTH have been described (47,48). Low calcitonin levels and decreased response to a calcium stimulus have been reported in osteoporotic patients (49,50). The decreased calcitonin response to calcium in older women can be reversed by estrogen therapy, and this effect does not appear to be altered by concurrent administration of vitamin D (51). Comparisons of patients who lose bone at relatively fast or slow rates have been carried out looking for differences in calcium regulating or steroid hormone metabolism. One study showed an increase in urinary free cortisol excretion in patients who showed more rapid bone loss after surgical castration suggesting that glucocorticoids might play a role in producing this difference (52). A decreased growth hormone secretion in response to pharmacologic stimulation has been reported in a small group of patients with postmenopausal osteoporosis (53). This change in growth hormone secretion could be due to estrogen lack since estrogens can increase growth hormone responses in normal subjects (54). On the other hand this effect of estrogen is associated with a decrease in serum somatomedin which presumably mediates the effects of growth hormone on the skeleton (54).

Decreased sex hormone production is certainly important in the pathogenesis of osteoporosis, but the mechanism is unknown. Bone mass is lost at an average rate of about 0.5% per year in both males and females after the age of 40. However, an accelerated rate of 1% per year or greater probably obtains for at least 10 years after the menopause which gradually slows to the lower universal rate (55,56). There is a small negative calcium balance before the menopause which is almost doubled after the menopause (57). This change is associated with a decrease in calcium absorption in the intestine and an increase in calcium excretion in the urine. The change in intestinal absorption could be due to decreased formation of calcitriol, but might also be due to some intrinsic change in the intestine itself since the response to vitamin D metabolites may also diminish with age. The increase in urinary excretion of calcium probably reflects increased bone resorption. This has led to the idea that estrogens normally cause a tonic inhibition of bone resorption and that their withdrawal at menopause results in increased resorption and bone loss. There are many clinical studies which show that post-menopausal women treated with estrogens show less bone loss (58,59). This effect is lost rapidly when estrogens are discontinued (60,61). However, the effect may not be estrogen specific since it can be produced by steroids which are weak androgens with protein anabolic activity and little estrogenic activity (62,63) and by certain progestins (64), but not with estriol in clinically prescribed doses (65). Moreover, pre-menopausal women given steroids which decrease endogenous estrogen production can show increased bone mass (66).

There is no evidence for an estrogen receptor in bone which might mediate a direct effect (67). Thus, it seems likely that estrogens, androgens, and progestins act through an as yet unknown intermediate to prevent accelerated bone loss in the menopause. Such an indirect effect might be mediated by an increase in the activation of vitamin D (68) or the secretion of growth hormone (53). Another possibility is that the sex hormones act through an effect on muscle. Certainly age-related loss of muscle mass occurs (69) and muscular activity is important in the maintenance of bone mass. Muscular activity can be shown to increase both local and total bone mass in elderly as well as in young individuals (70,71,72). While these factors may be important in the pathogenesis of clinical osteoporosis, it is important to recognize that none of them has been shown to be essential. Symptomatic osteoporosis can develop in physically active women who have been treated continuously with estrogen since menopause, while in others osteoporosis never develops despite the existence of multiple pathogenetic factors. The discovery of a completely unexpected etiologic or pathogenetic mechanism should not surprise us. One way to hasten such a discovery is to recognize our ignorance and try to develop a better basic understanding of skeletal metabolism and its control.

3. Predisposing Factors

Genetic factors are clearly important in the development of osteoporosis. Whites have a much higher incidence of osteoporosis than blacks. This does not seem to be attributable to a difference in the rate of age-related bone loss, but may be related to a greater bone mass in black populations earlier in life (73). Although the familial incidence of osteoporosis has not been well studied, identical twins do show a high concordance with respect to bone mass and age-related loss (74). Certain populations such as Eskimos have been reported to have rapid age-related loss and a high incidence of osteoporosis (75).

Nutritional factors may play a role (76). Calcium intake is consistently lower in women than in men, and the negative calcium balance of both pre- and post-menopausal women can be reversed by increasing calcium intake from about .6 to 1 to 2 grams of calcium per day (77). Low calcium intakes may be associated with a higher fracture rate of all ages (78). Lactose intolerance, related to intestinal lactase deficiency, may be more frequent in osteoporosis (79,80). High protein intakes could enhance bone loss. Protein feeding is known to cause increased urinary calcium excretion (81). Protein also constitutes an acid load and elderly individuals are less able to handle such loads because of their progressive loss in renal function. Protein-calorie malnutrition is associated with diminished bone mass in experimental animals and in growing children, and could be a factor in the osteoporosis associated with alcoholism and liver disease (82). Most women with osteoporosis are thin (83), and bone mass may be increased in obesity (84). There are data suggesting that bone loss may be greater in individuals who drink large amounts of coffee (85). Many patients with osteoporosis are cigarette smokers (83). This may be related to an earlier onset of menopause in women who smoke (86,87).

4. Differential Diagnosis

It is important to distinguish osteoporosis from other forms of bone disease because such disorders are often much more amenable to treatment. The term "osteopenia" has been used to describe individuals who present with symptoms due to decreased bone mass and impaired skeletal function but in whom the diagnosis has not yet been established (88). The major disorders which must be differentiated from osteoporosis are osteomalacia, primary hyperparathyroidism, hyperthyroidism, and bone loss due to malignancy, particularly multiple myeloma. In addition prolonged immobilization (89,90), glucocorticoid excess (15,91,92), chronic liver disease and alcoholism (93,94) and heparin administration (95,96) are associated with osteoporosis which should be distinguished from the post-menopausal, senile or idiopathic forms. The diagnosis of osteoporosis is made by exclusion; there are no pathognomic signs, symptoms, or laboratory abnormalities. However, there are simple screening tests, such as measurement of serum calcium, phosphate, protein electrophoresis, PTH, 25-hydroxyvitamin D, thyroid hormones and cortisol, which will rule out most other causes.

Some patients may show the combination of osteoporosis with another disorder. Primary hyperparathyroidism and hyperthyroidism are common in post-menopausal women (97,98), and treatment of these disorders may decrease skeletal symptoms. Osteomalacia can occur in elderly women and its detection is important because vitamin D and calcium therapy can lead to rapid improvement (99). Chemical changes of osteomalacia are not always present, but a positive diagnosis can be made by bone biopsy if the patient is given tetracycline to assess mineralization rate and undecalcified sections are examined. While such biopsies can not be performed routinely, they are useful in patients with atypical findings or severe progressive disease. Moreover, quantitative morphologic analysis of bone biopsies has helped to define the abnormalities in various forms of osteopenia.

5. Treatment

a. preventive measures

It is difficult to assess the various therapeutic measures that have been used in osteoporosis (100). Few studies have been carried out using randomized concurrent treated and control groups. Since the clinical course of osteoporosis is variable and there are often long asymptomatic periods, large numbers of patients would have to be followed for many years to prove that a particular therapy is clinically effective in preventing deformity and fractures. As an alternative, most investigators assess therapy by measuring changes in bone mass. Ideally the goal of therapy should be reversal of bone loss, but prevention is probably a more realistic goal.

A number of therapeutic programs have been shown to be effective in slowing bone loss in post-menopausal women. Hormone therapy usually involves the use of estrogens, either singly or in combination with androgens and progestins. Oral calcium or vitamin D supplementation has been used, and in some studies hormones and calcium have been combined. On the basis of these studies one can make the following tentative conclusions. 1) There are several different programs of sex hormone administration which can effectively slow post-menopausal bone loss. These effects can be sustained for up to 8 years after menopause and can decrease the frequency of fractures (101,102). 2) Calcium supplementation also slows post-menopausal bone loss, but may not be quite as effective as hormone therapy (103,104,105). 3) Discontinuation of sex hormone therapy can result in a rapid reappearance of the accelerated phase of bone loss in post-menopausal women. Discontinuation of calcium supplementation may not be followed by the same rate of relapse (60). 4) Vitamin D by itself has not been shown to be as effective as sex hormone or calcium supplements (106). 5) The costs and complications of estrogen replacement therapy are relatively high (107,108). Screening for endometrial cancer must be carried out and therapy is not acceptable to many patients because of uterine bleeding.

Beyond these points, on which there is considerable agreement, there is much uncertainty. None of these therapies have been compared with each other in large carefully-controlled prospective studies. The toxicity of estrogen has been intensively studied but is still controversial, although cost-benefit analysis indicates that estrogens should be used in patients at high risk for developing osteoporosis. The long-term toxicity of calcium or vitamin D supplementation is unknown. We have little idea how much clinical efficacy these programs will really have. Most patients with accelerated post-menopausal bone loss do not develop clinical osteoporosis, and many patients who are treated with estrogens and calcium supplementation still develop fractures. Selection of individuals for treatment according to risk factors would be ideal, but we don't know enough about these factors. To answer these questions we must study large numbers of patients for many years.

b. therapy for established disease

In patients with established osteoporosis and fractures a conservative approach, in the absence of definite evidence that other forms of therapy are useful, has been to give the patients calcium and vitamin D supplements and an exercise program. Patients who are less than 10 years post-menopausal are usually also offered estrogen replacement. There are no comparative studies to define the best amount and form of calcium or vitamin D to administer or to show whether any specific form of exercise is useful. Patients who are more than 10 years post-menopausal are often not given estrogen, but we don't know how late after the menopause estrogen should still be considered. An alternative approach is to combine these measures with some additional form of therapy.

Among other forms of treatment the choice often reflects a particular theory of pathogenesis. If increased bone resorption is considered to be the primary abnormality, then inhibitors of resorption would be indicated. However, continuous inhibition of bone resorption would decrease the appearance of new bone remodelling units. Hence new bone formation would be slowed and the adaptation of the skeleton to changing stress would be impaired (5). We know that the marked decrease in bone resorption which occurs in osteopetrosis produces a skeleton which is more subject to fracture than normal, even though the bone is abnormally dense (109,110).

An alternative goal of therapy would be to stimulate bone formation on the basis that even if this process is not absolutely decreased in osteoporosis, not enough new bone is formed in response to a small increase in resorption. However, it is important that the new bone be structurally effective. Increased bone mass due to stimulation of new bone formation occurs in endemic fluorosis, but this can also result in deformities and an increased incidence of fracture (111).

Finally, therapy has been designed to stimulate bone turnover in the hope that increasing the number of active bone remodelling units will help the skeleton to readjust to stress and increase the effective bone mass. One obvious drawback of this approach is that the initial step in bone remodelling is resorption. Hence any therapy which increases the number of remodelling sites will produce a transient decrease in bone mass until formation is able to catch up. Perhaps because of the limitations of each of these approaches, many investigators have recommended combined regimens using several different agents.

c. specific agents

i. calcitonin

The possibility that calcitonin might be useful in osteoporosis was considered early, after it was shown that this hormone is a potent inhibitor of bone resorption. In uncontrolled studies it was found to relieve pain and improve bone mass, but negative results were also reported (111-114). In a recent report 75% of patients treated with salmon calcitonin reported relief of pain, but only half showed an increase in total body calcium while in the remaining patients calcium actually decreased (115). The turnover of labeled calcium decreased in all patients. Because of the possibility that decreased bone turnover might vitiate any beneficial effects of calcitonin, combined therapy with agents which stimulate bone turnover has been suggested. For example, combined therapy with phosphate and calcitonin was reported to increase trabecular bone volume in patients with osteoporosis (116). While the available information certainly indicates that calcitonin is not highly effective when given alone, its intermittent use, combined with agents which stimulate bone turnover, certainly deserves further study. The use of calcitonin may be limited, however; because it is expensive, must be given by injection and produces side effects, particularly anorexia, nausea and vomiting, although these may not persist with continued administration. Another problem is that the only form currently available in the U. S. is salmon calcitonin, to which patients can produce antibodies. Synthetic human calcitonin has not yet been marketed in the U. S., but would probably be the preferred agent for long-term treatment of osteoporosis.

ii. metabolities of vitamin D

While the evidence that an abnormality of vitamin D metabolism is important in the pathogenesis of osteoporosis is limited, it is certainly possible to increase calcium absorption by administering active metabolites of vitamin D, and this in turn could result in improved calcium balance (117). A major concern is that excessive amounts of 1-hydroxylated metabolites could produce hypercalcemia and hypercalciuria and possibly impair renal function. Such effects have been observed with doses as low as 1 ug/day of 1α OH vitamin D or $1,25(OH)_2$ vitamin D (118,119). However, hypercalcemia is transient when these agents are used, in contrast to the prolonged toxicity that can occur with excess of vitamin D itself. In one recent study treatment with vitamin D produced an improvement in symptoms, but there was a high incidence of new fractures (120). Vitamin D administration did not prevent bone loss in a large group of post-menopausal women with osteoporosis who were selected for this treatment because they had poor intestinal absorption of calcium (106).

iii. fluoride

The use of fluoride for the treatment of osteoporosis was probably suggested by the clinical observation of increased bone density in patients with fluorosis. Osteoblastic activity can be stimulated by small doses of fluoride, but this new bone may not mineralize well unless supplemental calcium and vitamin D are administered so that combined therapy should always be used (121,122).. The increase in bone mass with fluoride treatment is apparent on bone biopsy, but the trabecular pattern is often irregular and this new bone may not be of as strong as normal bone. Another drawback to the use of fluoride is that many patients have disabling side effects including joint pain and gastrointestinal symptoms (123). Although fractures may occur during the first year of fluoride therapy, the rate appears to decrease with prolonged therapy, particularly in those who show a definite increase in bone density (124).

iv. parathyroid hormone

A collaborative clinical trial using low doses of the synthetic 1-34 active fragment of human PTH for the treatment of osteoporosis is currently underway (125). The rationale is that PTH will increase bone turnover. If the coupled osteoblastic response is sufficiently great, there may be an increase in trabecular bone mass. Such an increase has been observed in experimental animals (126). Among the limitations to the use of intermittent PTH are the fact that it must be given by injection and that an overdose could produce toxic hypercalcemia and excessive bone destruction.

v. phosphate

The idea that phosphate might be useful for the treatment of osteoporosis could have derived from its known direct effects on the skeleton which are to decrease resorption (127) and increase bone mineralization and matrix synthesis (128). However, when phosphate is given in vivo, it produces hypocalcemia and this in turn results in secondary hyperparathyroidism and an increase in bone resorption and turnover (129). Thus phosphate administration might provide an inexpensive oral form of intermittent endogenous PTH therapy. Large doses of phosphate cause diarrhea and may produce irreversible soft tissue damage due to deposition of calcium and phosphate in the kidney, lungs and vessels. While it seems unlikely that phosphate alone will be an effective treatment for osteoporosis (129), it may be useful in combination with other therapy (116).

vi. anabolic hormones

Anabolic steroids, which are also androgens, have been shown to increase bone mass in some patients with osteoporosis (62). The androgenic activity is a major drawback since these agents may produce masculinization in post-menopausal osteoporosis. Growth hormone has been administered to only a few patients with osteoporosis. There was no consistent increase in bone mass in these patients, and some of the adverse effects of excess growth hormone such as joint stiffness, carpal tunnel syndrome and other signs of acromegaly were observed (130). It is possible that a growth hormone dependent factor or somatomedin might be useful in the treatment of osteoporosis, but these factors have not yet been isolated in sufficient quantity to test in patients; moreover, they have been relatively ineffective in stimulating skeletal growth in experimental animals.

vii. diphosphonates

The diphosphonates are stable analogues of pyrophosphate which can block bone resorption. One agent, etidronate, has been tried in osteoporosis with little benefit (131). Newer diphosphonates may be more selective but have not yet been used in osteoporosis (132).

6. Methods for the Study of Skeletal Mass and Function

The lack of precise methods for assessing bone mass and skeletal function has been a serious impediment to progress in the study of osteoporosis. Ordinary radiologic examination can only be used to detect advanced osteoporosis and assess fractures and deformities. Attempts to refine radiologic assessment such as the Singh index have had little success (133). Quantitative radiographic studies, particularly of the metacarpal bones, can be used to follow age-related bone loss (134). It is likely that computerized tomography can be used to measure bone mass in the vertebrate as well as the long bones with greater precision (135). Measurements of bone density in the forearm by photon absorptiometry can provide reproducible data and correlate reasonably well with other measures of bone mass (136). A new method for the assessment of the lumbar vertebrae using dual beam photon absorptiometry may make it possible to assess the axial as well as the appendicular skeleton (137). All of these methods are valuable for comparing populations and for following the progress of an individual patient on treatment. They are not diagnostic, however, because there is substantial overlap among patients who have no symptomatic osteoporosis and those who have severe symptoms and multiple fractures. Among the factors responsible for this overlap is the fact that the strength of the skeleton is not solely determined by the bone mass (138). This is particularly true in patients with osteomalacia who may show an increase in total bone mass but develop deformities and fracture associated with large amounts of unmineralized osteoid and a distorted skeletal structure. In osteoporosis there may be healed microfractures in which the trabeculae are thickened but structurally ineffective. Attempts have been made to assess the structural integrity of bone in vivo using a variety of physical techniques, but these have not yet been applied in clinical studies (139).

Ordinary chemical analyses show no abnormality in the blood or urine of patients with osteoporosis. Fasting urinary hydroxyproline and calcium are slightly increased, but there is much overlap between patients with osteoporosis and age-matched controls. The possibility that some specific matrix component might provide a measure of bone resorption certainly deserves further study. Recently a calcium binding protein which contains gamma-carboxy glutamic acid has been discovered in bone, and preliminary studies suggest that its excretion is increased when bone breakdown is accelerated (140).

There are specialized research techniques for the study of osteoporosis which have been limited to relatively few patients. Kinetic analysis using labeled calcium is useful in assessing bone turnover (141). Measurements of calcium content by neutron activation analysis can be carried out for the whole body or can be limited to the spine or extremities (142,143). This technique is more accurate than densitometry but does not distinguish between bone and soft tissue calcium. Hence it may be misleading in patients who have extensive vascular or soft tissue calcification. Moreover, it requires specialized apparatus and is currently available in only a few centers. Measurements of calcium absorption and turnover using isotopes can be of great importance in studying pathogenesis and assessing the effects of therapy but are limited by the requirement for the use of radioactive isotopes. Stable isotopes of calcium which can be subsequently analyzed by neutron activation might provide an ideal replacement for radioactive calcium since they could be used repeatedly without hazard to the patient (144). Bone biopsies can give an excellent picture of the amount and cellular activity of bone but are difficult to perform and analyze. The fact that biopsies are limited to a small sample of the skeleton does not seem to be as great a drawback as might be supposed since the correlation with other parameters involving the whole skeleton is generally good (145, 146).

IV. DIRECTIONS FOR FUTURE RESEARCH

There are so many fundamental areas in which we lack sufficient knowledge that it is probably inappropriate to suggest any specific program to attack the problem of osteoporosis at the present time. We need a better understanding of the basic cell biology of bone. We need to know how osteoclasts and osteoblasts differentiate and function at different ages and what controls these processes. We need to know how resorption and formation are coupled. We need to know how estrogens act and what causes accelerated bone loss at the menopause. Ideally some should be carried out in animals; however, the available animals models of osteoporosis bear little resemblance to the human disorder (147-152), and the particular pattern of age-related bone loss with post-menopausal acceleration occurs only in humans.

We need better methods for the clinical assessment of skeletal structure and function. A sample blood urine measurement which would reflect the rates of bone resorption and formation with reasonable accuracy would be particularly useful. Better methods for measuring bone density should become available as radiologic techniques improve. A method for assessing bone strength in vivo might enable us to predict the likelihood of fracture.

Since it may take many years to develop a basic understanding of bone biology, we should not neglect the immediate possibility of testing the available forms of therapy. The most promising approach is to develop better preventive measures. It should be possible to design a clinical trial in which large numbers of patients are treated with calcium, exercise, vitamin D and sex hormones in various combinations and followed for changes in bone mass and the occurrence of fractures. However, the frequency of development of symptomatic osteoporosis may be too low to make such a trial practical unless a high risk population can be defined. We need to know more about the relative importance of risk factors for the development of clinical osteoporosis before we can select the appropriate population for a trial of preventive measures. Current evidence for the efficacy of various programs for the treatment of established osteoporosis is limited and it would be difficult to find a consensus concerning the design and conduct of a clinical trial to compare these regimens. As new information is obtained, it should be more feasible to design therapeutic trials. A central agency for continuous assessment of current clinical data should be established with the aim of achieving the earliest possible implementation of prospective clinical trials in the prevention and treatment of osteoporosis. Careful planning is necessary because a meaningful clinical trial in osteoporosis must involve multiple centers and will be expensive and difficult. Large numbers of patients will have to be followed for long periods because of the variability of the clinical course. Patients will have to be stratified according to the presentation of the disorder, for example, whether they have crushed vertebrae, fractures of the hip or wrist or simply decreased bone density. Such factors as diet, climate, exercise and racial and ethnic composition of the population studied will have to be controlled.

Thus any attack on the problem of osteoporosis should be based on two simultaneously but widely different approaches. On one hand, the research efforts of individuals and small groups studying basic bone biology and mineral metabolism should be encouraged. On the other hand, cooperative clinical trials should be undertaken based on a consensus reached by the cooperating investigators and advisors representing a broad range of views.

V. CONCLUSIONS

Osteoporosis is a major public health problem, particularly in post-menopausal women. Since osteoporosis is the clinical expression of age-related bone loss, its incidence and severity is likely to increase as the proportion of older individuals in our population increases. Our understanding of bone biology and the mechanisms of age-related bone loss is limited. We do not know the pathogenesis of osteoporosis nor do we have any effective treatment. Moreover, osteoporosis may not be one disease but a group of disorders whose separate characteristics have not yet been defined. Solutions to this problem require better understanding of bone cell metabolism as well as the development of new diagnostic tests and therapeutic agents. We do not have precise techniques for assessment of the severity of progression of osteoporosis or the response to treatment. Since the disorder progresses slowly and has a variable course, demonstration of the effectiveness of therapy will require large clinical trials carried out for long periods. Because their cost is so high, clinical trials should only be undertaken if there is a reasonable likelihood that they will produce useful information. A mechanism should be developed by which current research is continuously reassessed to determine when there are sufficient data to justify a large clinical trial comparing different programs of prevention and treatment.

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PHARMACOLOGY AND AGING

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INTRODUCTION

Geriatric clinical pharmacology: an overview.

The elderly are in many ways a more heterogeneous group than the young. Because of wide differences in the rates of deterioration of organs and enzyme systems with age, it is not possible to establish a guideline to allow for altered drug responses. Effective and safe use of drug therapy for old people is, therefore, a matter of individual prescribing and treatment.

The key factors to consider in geriatric clinical pharmacology are the appropriateness of the therapeutic regimen, the individual's physical and psychological tolerance to the drug, and the difficulties affecting compliance. A patient should always be given the fewest number of necessary drugs. The more drugs prescribed, the greater the likelihood of toxicity resulting from adverse drug reactions and drug interactions. An additional reason for keeping the regimen simple is that slowness of comprehension, physical disability and lapses of memory in elderly patients may result in self-administered medication errors. For example, Bergman and Wiholm (1981) have observed that both the total number of drugs (more than 3 drugs) and the frequency of daily doses (more than twice daily) was associated with non-compliance, particularly in the elderly.

The ideal simplified therapeutic regimen is difficult to attain, however, because elderly patients frequently have multiple diseases which require multiple drugs. Because the incidence of adverse drug reactions increases with the number of drugs administered, the older person is predisposed to complications. Furthermore, disease-related alterations in physiology in the elderly combine with normal age-related alterations in physiology to affect both drug metabolism and drug response.

According to recent statistics, in 1978 the aged constituted about 11% of the population and spent over 21% of the national total of $15.1 billion for drugs. If current trends continue, we may expect that by the year 2030 expenditures for drugs by the elderly in the United States may be over 40% of the national total. In the United Kingdom, where the elderly represent only 12% of the population, they are responsible for about 30% of the national health expenditures on drug prescriptions. In fact, in most developed countries the elderly constitute 10% or more of the population, but spend 25% to 30% of total expenditures for drugs and drug products.

Recognizing this common conern, the European Office of the World Health Organization convened a Technical Group on the Use of Medicaments by the Elderly in Geneva, Switzerland, in September 1980 to discuss geriatric clinical pharmacology. One important conclusion agreed upon was that aging is not in and of itself a disease and, therefore, not treatable by drugs. This conclusion is supported by Fries (1980). He contends that natural death may occur without disease and that physical changes considered manifestations of disease in the young are not necessarily so in the aged. Although mortality is inevitable, Fries states, social interaction, promotion of health, and personal autonomy can compress the period of morbidity in the human life span. Conversely, there is no convincing evidence that drugs such as the heavily advertised procaine hydrochloride have any value in the treatment of disease in older patients (Ostfeld et al., 1977).

Many elderly patients are, in fact, being overmedicated and improperly medicated. Medication has all too often become a substitute for individual medical treatment. Because of this, it is important to define basic principles of geriatric prescribing.

1) Strive for a diagnosis prior to treatment.

An elderly person's symptoms may be due to malnutrition, ill-fitting dentures, social deprivation, inability to pay for previously ordered medication or abuse or misuse of medications. Additional drug therapy would only be likely to complicate the situation.

2) Take a careful drug history.

This is especially important in dealing with the elderly. The patient may be receiving two or more drugs of the same type, or with similar side effects, perhaps prescribed by the same or different clinicians. Additive anticholinergic side effects may result from concurrent use of such drugs as antidepressants, antipsychotic agents, antihistamines, and non-prescription "cold" remedies. A problem-oriented medication list, or some other systematic record, should be maintained for each individual as an aid to a treatment program.

3) Know the pharmacology of the drugs prescribed.

Use a few drugs well rather than many drugs poorly. A clinician's ability to use a drug rationally will be enhanced by an understanding of its route of elimination, half-life, protein binding properties and propensity for interactions with other drugs, along with a knowledge of its major pharmacological actions, side effects and toxicity.

4) Titrate drug dosage with patient response.

Try to identify signs or symptoms that can be monitored serially. Increase drug dosage gradually until the desired therapeutic end point is reached or toxicity is present or anticipated. Judicious monitoring of plasma levels may be useful guides to therapy with some drugs.

5) Use smaller doses in the elderly.

The usual dose for young patients may be too large for the older patient. In general, caution is a virtue in geriatric therapy. While the loading dose may not require much alteration, the initial maintenance dose may need to be reduced by 25% to 30%. Examples include diagoxin and theophylline.

6) Simplify the therapeutic regimen.

Complex drug regimens may easily be mismanaged by the elderly patient with a deteriorating memory or impaired vision. In order to promote comprehension and compliance, the following steps are suggested:

a) Explain the treatment plan to both the patient and a friend or relative and give concise written directions.

b) Choose a dosage form that is appropriate for the patient. A liquid may be more suitable than tablets for a patient who has difficulty swallowing. There is current interest in Europe in the development and testing of high-quality rectal suppositories which stimulate intravenous administration by slow even absorption from the rectal mucosa. With proper placement of the suppository, pre-systemic metabolism by the liver can be avoided to a great extent.

c) Suggest the use of a diary or calendar to record daily drug administration.

d) Label the drug container clearly and when appropriate specify standard containers. The arthritic patient will have difficulty opening safety caps.

e) Encourage the return or destruction of old unused medications. The accumulation of old medications from prior treatment programs will only serve to confuse the patient.

7) Regularly review the drugs in the treatment plan and discontinue those not needed.

Review the indications for each drug in a patient's treatment plan at least once every three to six months. Medications given for specific indications may be continued long after the problem has been resolved. This is particularly true when patients are seen by a number of clinicians over a period of time.

8) Remember that drugs may cause illness.

Drugs may be a possible explanation for unusual symptoms. Avoid substituting prescriptions for taking adequate medical and social histories.

Often the relationship of the clinician with his patient is more important than the drugs he prescribes. The patient needs to be a partner in his treatment program and needs encouragement to learn to adjust to and live with his disease or disability. Geriatric patients, like most other patients, greatly appreciate a clinician who is sincerely interested in their emotional and social, as well as medical, well being.

REVIEW OF LITERATURE AND CURRENT RESEARCH

Drug use patterns in the elderly.

Epidemiological data are difficult to compare, not only within the United States, but also within and between other countries. Since drug consumption varies widely in different countries, the Nordic countries have used the Defined Daily Dose (DDD) to lessen this difficulty (Bergman et al., 1980). This methodology should be used for future studies in the United States as well.

Hospital population.

A study by the Boston Collaborative Drug Surveillance Program showed that on the average, U.S. medical hospital in-patients have received 9.1 drugs, 7.1 for Canada, 6.3 for Israel, 6.8 for New Zealand, and 4.6 for Scotland (Lawson and Jick, 1976). A comparison between Scotland and the United States shows that in the United States, patients were treated more intensively for diarrhea, dehydration, constipation, diabetes, and hypertension. Anxiety, pain congestive heart failure, anemia, were treated similarly in the two countries. Differences in prescription patterns were more obvious in Scotland for treatment of infections, where three antibiotics versus ten in the United States were used to treat 75% of the infections.

Ambulatory population.

The HEW Task Force on Drug Prescriptions in 1968 reported the three most commonly prescribed drugs for the elderly to be diazepam, chlordiazepoxide, and the non-narcotic analgesic propoxyphene. However, in a study of an ambulatory community-dwelling population, Chien et al. (1978) found the most commonly used medications to be: analgesics 66.6%, cardiovascular preparations 33.5%, laxatives 30.6%, vitamins 29.3%, antacids 26.4%, and anti-anxiety agents 22.3%. Of the [illegible] individuals over 60 years of age studied, 83% were taking two or more preparations. Over-the-counter (OTC) preparations accounted for 40% of the medications and 60% were prescribed.

In a similar study Guttman (1978) found that most frequently used classes of medications were cardiovascular 61.3%, sedatives and tranquilizers 16.6%, anti-arthritic preparations 12.1%, gastrointestinal preparations 11.4%. Over-the-counter drugs were used by 69% of this sample of 447 subjects, 51.7% using analgesics; vitamins and laxatives were respectively used by 8.1% and 7.1% of this group.

Because of the use of OTC preparations on an "as needed" (prn) basis, different drug classification, and different patient selection, these data are difficult to compare. However, non-narcotic analgesics appear to be the most commonly consumed non-prescribed drugs, with cardiovascular preparations and psycho-active substances being the most commonly prescribed medications. Older patients are probably not more avid OTC consumers, however, than other segments of the population (Bush et al., 1976).

Long-term care facilities.

Borda et al. (1976) found that patients hospitalized in long-term care facilities in Boston received a mean of eight drugs in the first 10 days. In another survey (Kalchthaler et al., 1977) psychotropics were shown to be the most commonly prescribed (61%), followed by diuretics and anti-hypertensive drugs (45%), anti-microbials (14%), and cardiotonics (14%). The contribution of the consultant pharmacists to rational drug usage in the long-term care facility has been highlighted by Cooper et al. (1978) who showed that in a year, scheduled drugs were reduced by 19.4%, the overall reduction going from 7.2 to 4.8 drugs per patient. It is noteworthy that psycho-active drugs (Ingman et al., 1975) were more often prescribed to patients with superior mentation and minimal physical disabilities than to those who were more severely disabled.

A study suggesting misuse of antipsychotic drugs in nursing homes by Ray et al. (1980) matched each resident with an ambulatory person enrolled in Medicaid throughout the study year. Among nursing home patients, central nervous system (CNS) drugs were the most frequently prescribed medications (74% of the patients). In contrast, only 36% of the ambulatory comparison groups received CNS drugs. Nursing home patients often received prescriptions from multiple categories of CNS drugs: 3.4% from two or more different categories, 9% from three or more, and 1.6% from four categories. The most frequent combination was an antipsychotic and sediative-hyponotic, most commonly thioridazine and flurazepam. The next most frequent combination was a minor tranquilizer and sedative-hypnotic drug, usually diazepam and chloral hydrate. The three most frequently prescribed antipsychotic drugs were thioridazine, chlorpormazine and haloperidol. Ray suggests these drugs may be used to mold patients into the institutional routine.

Physiological effects of aging.

Drug absorption. Bender (1968) has suggested several reasons why drug absorption from the gastrointestinal tract might be altered by old age. Elevated gastric pH could change the ionization and solubility of some drugs. Reduced intestinal blood flow along with delayed gastric emptying and decreased gastro-intestinal motility might lessen the rate of drug absorption. Although careful studies of drug absorption are few, higher rather than lower plasma levels after oral administration of several drugs have been found in elderly as compared to younger patients. However, these differences can probably be explained by decreased hepatic elimination or by alterations in drug distribution rather than in differences in drug absorption (Crooks et al., 1976; Vestal 1978).

Drug distribution. Probably the most important single factor changing drug distribution in the elderly is simply that these patients differ from younger patients in terms of body composition. Less total body water and more body fat reduce the proportion of actual lean body mass per unit of total body weight. Thus, one might predict that drugs that are distributed mainly in body water or lean body mass might have higher blood levels in the elderly, particularly if the dose is based on total body weight or surface area. This is true for ethanol which distributes in body water (Vestal et al., 1977). Higher peak ethanol levels were observed in older subjects without a difference in rates of metabolism. Although confirmatory studies are not available, alterations in body fat may result in accumulation and prolongation of action of highly lipid soluble drugs. A smaller volume of distribution in the elderly may also contribute to the higher blood levels of digoxin in the elderly (Cusack et al., 1979).

Plasma albumin levels are generally lower in the elderly, which means that more free drug may be available at sites of drug elimination and drug response. This would be of particular importance in the case of drugs which are highly protein bound. For example, total plasma clearance of phenytoin has been shown to increase with age as a result of decreased plasma binding (Hayes et al., 1975b). For some drugs the volume of distribution may be larger in the elderly. In a systematic study of the effect of age on the disposition of diazepam (Koltz et al., 1975), a positive correlation was found between age and the apparent volume of distribution at steady-state. No alteration of plasma protein binding was observed and plasma clearance was unaltered. It is reasonable to expect that canges in apparent volume of distribution and correspondingly prolonged plasma clearance of such drugs may lead to altered pharmacological effect.

Drug elimination. In general, drugs are either excreted unchanged by the kidney or are metabolized in the liver to less active or totally inactive compounds before excretion. Renal excrction, and for some drugs metabolism, become less efficient with advancing years (for reviews, see Crooks et al., 1976; Vestal, 1978; O'Malley et al., 1980; Plein and Plein, 1981). This decreased capacity to eliminate some drugs may be one important reason for the increased sensitivity of the elderly patient to therapeutic agents.

Animal studies also suggest the metabolism of drugs is altered as a function of age along with alterations in the response of "old" experimental animals as compared with young to a variety of drugs (Schmucker 1979). In his review considerable evidence is given of age-dependent decline in the activities and adaptive capacity of liver microsomal drug-metabolizing enzymes. Most of the clinical data, however, are indirect. Schmucker stresses that apparent age-related change may not be universal and, that species, strain and sex differences are complicating factors in animal research.

Several studies with antipyrine have consistently reported a prolong half-life and reduced metabolic clearance in older subjects (O'Malley et al., 1971; Liddell, et al., 1975; Vestal et al., 1975). Antipyrine is a useful model compound because it is only minimally protein bound and is extensively metabolised by the liver prior to excretion. Data also suggests that reduced antipyrine metabolism correlates with a reduction in liver volume in elderly subjects (Swift et al., 1973). The largest available study of antipyrine metabolism, however, showed that interindividual variation (6-fold) exceeded the effect of age and only 3% of the variance in metabolic clearance could be explained by age alone (Vestal et al, 1975). Most of this wide interindividual variation in drug metabolism is undoubtedly due to a variety of genetic and environmental factors (Vesell, 1977; Vesell, 1979). Thus, age itself probably has only a minor influence on rates of metabolism of antipyrine in adults. Interestingly, the rate of ethanol and isoniazid elimination is unaffected by age (Vestal et al., 1977; Farah et al., 1977). Ethanol is mainly metabolised by alcohol dehydrogenase and isoniazid is acetylated. Neither of these pathways occur in the microsomal fraction in contrast to antipyrine, which is metabolised by hepatic microsomal enzymes. For drugs with high hepatic extraction ratios, such as lidocaine or indocyanine green whose metabolism is highly dependent upon liver blood flow which declines with age, one might predict an effect of age on hepatic drug clearance (Nies et al., 1976). Suprisingly, while the volume of distribution is larger and half-life longer in older subjects, there is no apparent effect of age on lidocaine clearance (Nation et al., 1977).

Further studies with model compounds (antipyrine, indocyanine green and propranolol) seem to support the general conclusions that liver blood flow decreases with age, that intrinsic hepatic metabolizing activity may not necessarily decrease with age, and that environmental factors, such as cigarette smoking, seem to have less enzyme inducing effect on the aged (Vestal and Wood, 1980).

Adverse drug reactions in the elderly.

Adverse drug reactions are most frequent in patients taking many drugs and in patients with abnormal renal function, infections or previous drug reactions (Smith et al., 1966). In a study of 714 hospitalized patients at John Hopkins Hospital, Seidl and his associates (1966) found that 24% of patients over the age of 80 had adverse drug reactions, compared with 11.8% of patients 41 to 50 years old. An even larger study in Belfast showed the overall incidence of adverse drug reactions to be 10.2% in 1160 consecutive patients, but 15.4% in patients over 60 and 20.3% over age 70 (Hurwitz, 1969). Although these studies were conducted in a hospital setting, adverse drug reactions leading to hospital admissions have been documented in outpatients as well. Of 236 consecutive patients admitted to an Australian psychogeriatric unit, 37 (16%) were suffering the direct effect of psychotherapeutic medications (Learoyd, 1972), seven patients were excessively sedated or confused, 14 patients had disinhibition reactions with restlessness, agitation, paranoia and agression, and 16 patients had psychic disturbances associated with respiratory depression, hypotensive syncope, urinary retention and gastrointestinal ileus. Many of the latter group had falls and three suffered fractures. All improved and were discharged from the hospital when their medication was significantly reduced or stopped. Investigators at the University of Florida Hospital found that 3% of 6063 consecutive admissions were necessitated by drug-induced illness (Caranasos et al., 1974). 41% of these 177 patients were over age 60. Adverse drug reactions, medication errors, and inappropriate or irrational therapy are also being recognized increasingly by clinical pharmacists conducting studies and working in extended care facilities (Cheung and Kayne, 1975; Bergman, 1975).

Cardiac Glycosides.

A major cause of adverse drug reactions in most studies is digitalis intoxication. Elderly patients are frequently afflicted by cardiovascular disease requiring the use of digitalis preparations often in combination with diuretics. There is not good evidence, however, that the elderly are inherently more sensitive to the therapeutic and toxic effect of digitalis. Chamberlain et al. (1970) measured plasma digoxin concentrations in 116 patients with atrial fibrillation on long-term oral treatment. The mean plasma concentrations in both the young group (aged 32 to 59) and the old group (aged 60 to 84) were identical (1.5 ng/ml). All patients had well-controlled ventricular rates between 60 and 80 beats per minutes with slightly greater variance in the elderly. The plasma levels in the older age group were attained with a mean dose of 0.32 mg per day compared with 0.42 mg per day in the younger group, but this was explained by the reduced renal function in the aged patients.

The half-life of digoxin has been shown to increase as much as 40% in the elderly with a decline in creatinine clearance (Ewy et al., 1969). In the small elderly patient with reduced lean body mass and impaired renal function, both the loading dose and maintenance dose should be reduced empirically.

However, plasma digoxin levels correlate with symptoms of toxicity and should be used to achieve optimum maintenance dosage. The clinician should be alert to symptoms suggesting digitalis intoxication such as fatigue, anorexia, visual complaints, nausea and psychic disturbances such as bad dreams, restlessness, nervousness, agitation, listlessness, drowsiness, fainting and pseudohallucinations, as well as more overt signs of toxicity such as rhythm disturbances (Lely and van Enter, 1972). It should be remembered that not all patients taking digitalis need maintenance therapy. One study showed that almost 75% of elderly patients in sinus rhythm on maintenance digoxin therapy could be safely withdrawn from treatment (Dall, 1970). A recent report on the use of digoxin in a group of elderly patients revealed that only about one-third were receiving an ideal dose and withdrawal of the drug or revision of dosage where appropriate resulted in clinical benefit (Whiting et al., 1978).

β-Adrenoceptor Blockers.

Evidence is accumulating that there may be fundamental age differences in the pharmacology of the autonomic nervous system. Although there is conflicting evidence (de Champlain and Cousineau, 1977), some recent studies indicated that plasma norepinephrine levels correlate positively with age (Lake et al., 1977; Sever et al., 1977). Rowe and Troen (1980) suggest discrepancies in published reports of the relationship between age and basal norepinephrine levels might be related to the varying definitions of "basal" and might also be explained by difference in subject selection. Although it appears from some data that there is no increase in basal circulating norepinephrine with age, they believe the physiological significance of an increase might relate to decreased responsiveness of end organs with age or to central nervous system changes resulting in greater tonic input into the brainstem areas regulating sympathetic outflow.

The number of β-adrenoceptors in membrane fractions of lymphocytes have been found to correlate negatively with age without apparent alteration in receptor affinity (Schocken and Roth, 1977). Using the lymphocyte system, Dillon et al. (1980) have shown lower levels of cyclic AMP in membrane preparations from elderly subjects compared to young after β-adrenergic stimulation. Perhaps observations help explain why resistance to the chronotropic response of the heart to isoproterenol has been shown to correlate positively with age (London et al., 1976; Vestal et al., 1979b).

Pharmacokinetic age-related differences have also been reported for β-blocking agents. Castleden et al. (1975, 1979) found a three to four-fold increase in plasma propranolol levels after a single 40 mg dose in a group of elderly as compared with a group of young subjects. It was proposed that the higher plasma levels in the elderly were the result of reduced hepatic extraction and metabolism, in particular a reduced hepatic first-pass effect. Our own subsequent study showed the presence of age-related pharmacokinetic differences during continuous repeat dose conditions, but they were of lesser magnitude and appeared to be explainable on the basis of reduced effect of cigarette smoking in the aged subjects (Vestal et al., 1979a). However, the dose used in our studies was higher than that used in the Castleden study. Conceivably, the threshold for maximum hepatic extraction may be age-related. A reduced threshold in the elderly could result in saturation of the extraction process at lower doeses than in the young. The higher dose chosen for our study may have obscured such a difference in threshold.

Support for this explanation is provided by the recent report of Schneck et al. (1980) who examined the influence of dose on the intrinsic clearance of propranolol in four healthy elderly and six healthy young subjects--all of whom were nonsmokers. In the elderly group there were no significant differences in the intrinsic clearance among doses. In contrast, in the young group intrinsic clearance decreased significantly with increasing dose. Thus, an effect of age on instrinsic clearance was demonstrated at the lowest dose (20 mg), while at the highest dose (160 mg) there was no significant difference between the two age groups. These data are certainly compatible with the conclusion that in nonsmokers the effect of age on the hapatic metabolism of propranolol is a dose-related phenomenon. It is possible that these pharmacokinetic age related differences for propranolol may contribute to the higher incidence of propranolol toxicity (such as bradycardia, pulmonary edema and hypotension) in patients 60 years or older (Greenblatt and Koch-Weser, 1973), but it is more likely that the elderly are predisposed to toxicity because of more extensive cardiovascular disease, diminished renal function with azotemia, and use of multiple cardiovascular drug therapy.

Antihypertensive agents.

Postural hypotention is common in the elderly, largely because of an impaired baroreceptor response (Gribbon et al., 1971) and a reduction in peripheral venous tone (Caird et al., 1973). These factors complicate the use of antihypertensive medications as well as diuretics in elderly patients since the [illegible] must be titrated even more cautiously than in younger patients to avoid severe orthostasis and synocope.

Older patients also seem clinically to be very sensitive to the antihypertensive and the central nervous system depressant effects of methyldopa and other agents with similar properties (Dollery and Harington, 1962). The use of reserpine is to be discouraged because of its tendency to cause gastric ulceration and an insidious form of psychic depression. Certainly, the injudicious use of antihypertensive therapy in the elderly must be avoided since the complications can be serious (Jackson et al., 1976), but the available data indicate that elevated diastolic and systolic blood pressures are both important risk factors for cardiovascular disease in individuals over age 65 as well as in those less than 65 (Dyer et al., 1977). Treatment should be cautious with careful attention to orthostatic hypotension as well as diuretic induced hypokalaemia.

Bronchodialators.

Although the results of some studies are conflicting (Nielsen-Kudsk et al., 1978; Cusack et al., 1980), a nomogram for the clinical use of intravenous infusions of theophylline includes age as a variable and is based on data which indicate that the maintenance rate should be reduced by approximately 25% in the elderly to maintain plasma levels in the therapeutic range (Jusko et al., 1977). Surprisingly, there is no clear evidence that the elderly are more susceptible to the toxic effect of theophylline than are younger patients. While there are case reports in the literature of seizures in elderly patients receiving theophylline (Zwillich et al., 1975), in most instances elevated plasma levels were present. Certainly, it is likely that because of increased prevalence of cardiovascular disease, the elderly will be more sensitive to the toxic arrhythmias induced by theophylline.

Anticoagulants.

There is some evidence that elderly individuals are more sensitive to the effects of both heparin (Jick et al., 1968) and warfarin (O'Malley et al., 1977). No information is available regarding the disposition of heparin in older patients. The increased risk of haemorrhagic complications may in part be due to diminished mechanical haemostatic response in the presence of degenerative vascular disease. With warfarin, at concentrations much above therapeutic plasma levels, a decrease in the binding capacity of elderly people was demonstrated which correlated with a fall in plasma albumin concentration (Hayes et al., 1975a). At therapeutic concentrations no effect of age was observed, nor were any other pharmacokinetic age related differences demonstrated (Shepherd et al., 1977). However, at similar plasma warfarin concentrations there was greater inhibition of vitamin K-dependent clotting factor synthesis in the elderly without a difference in the rate of clotting factor degradation. Possible explanations offered for these interesting observations were that the elderly have a decreased affinity for vitamin K and are relatively deficient in vitamin K due to reduced dietary intake, defective absorption or altered pharmacokinetics of the vitamin itself (Shepherd et al., 1977). It should be noted that not all investigators agree that sensitivity to warfarin is increased in the elderly (Hotraphinyo et al., 1978; Jones et al., 1980).

Sedative-hypnotic and auxiolytic agents.

The increased sensitivity and paradoxical response of the aged to barbiturates is accepted. In a significant proportion of elderly patients, it is said that the response may vary from mild restlessness to frank psychosis. For this reason, barbiturates probably have little role in geriatric therapy. However, there is actually relatively little objective data on this subject and what data are available suggest different conclusions (Morgan et al., 1973). Traeger et al. (1974) showed the half-life of phenobarbital increases from 71 hours in a young age group to 107 hours in subjects over age 70. Oral amobarbital has also been shown to give higher plasma levels in an elderly patient group (Irvine et al., 1974). There was also a marked reduction in excretion of the 3-hydroxy metabolite. These pharmacokinetic differences were attributed to impaired metabolism in the older subjects, but an effect of age on renal excretion cannot be excluded.

Considerable information is accumulating on the pharmacokinetics and pharmacodynamics of the benzodiazepine group of compounds in the elderly. Studies by Klotz et al. (1975) demonstrated that although a four to five-fold increase in the plasma half-life of diazepam is needed to achieve steady state, accumulation to excessive plasma levels is unlikely. Reanalysis of data originally reported by Andreasen et al. (1976) on the pharmacokinetics of diazepam in normal subjects (age 26 to 49) and patients with cirrhosis (age 23 to 68) has further emphasized that age, sex and body size should be included as independent variables in pharmacokinetic studies (Greenblatt et al., 1978). Stepwise multiple regression indicated that age and liver disease were equally important determinants of elimination half-life and together accounted for 34% of the variance in half-life. Age and sex collectively accounted for 33% of the variance in the volume of distribution. However, confirming previous studies (Klotz et al., 1975), liver disease was the single most important determinant of weight-corrected diazepam clearance. Reidenberg et al. (1978) have shown negative correlations between age and titrated dose and between age and resultant plasma levels of diazepam in patients receiving this drug as sedation for elective cardioversion. These data clearly indicate an increased sensitivity of the elderly nervous system to the depressant effects of diazepam. This study confirms previous findings [illegible] increased clinical depression of the central nervous system by diazepam and chlordiazepoxide in relation to age (Boston Collaborative Drug Surveillance Program, 1973).

Greater impairment of psychomotor performance has also been reported in the elderly than in young subjects following a 10 mg oral dose of nitrazepam (Castleden et al., 1977). No pharmacokinetic differences between the two groups could be demonstrated. Although prolongation of the half-life of lorazepam has been shown in one study in elderly subjects (Kyriakopoulos, 1976), Kraus et al. (1978) reported no difference in his study between young and old groups. A two to three-fold prolongation in the elimination half-life of chlordiazepoxide from 9-12 hours to 17-30 hours has, however, been observed. This was due to a proportional difference in the systemic clearance of the drug in the absence of any alteration in plasma binding or drug distribution in one study (Roberts et al., 1978), and to a difference in both and clearance and distribution volume in another study (Shader et al., 1977). Oxazepam elimination, on the other hand, appears to be unaffected by age. Thus, despite structural similarities there appears to be no consistent pattern by which aging affects disposition of the benzodiazepines. These drugs are now widely accepted to be the antianxiety drugs of choice.

The elderly are more susceptible to the toxic effects of flurazepam (most drowsiness, confusion or ataxia) and for this reason a low initial dose (15 mg) is preferable (Greenblatt et al., 1977). Another example is ethanol. When controlled for equivalent levels, healthy elderly subjects receiving ethanol demonstrated greater impairment of reaction time, memory and auditory attention than younger subjects (Robertson-Tchabo et al., 1975).

While there is some objective information about the pharmacology of other drugs acting on the central nervous system, such as the tricyclic antidepressants, antipsychotics, anti-Parkinsonian drugs and anticonvulsants, much more research data are needed.

Methodological problems in studies of geriatric drug metabolism.

Proper evaluation of the literature in geriatric clinical pharmacology and proper design of future studies requires familiarity with the strategies and pitfalls peculiar to research in clinical gerontology (Rowe, 1977; Rowe and Troen, 1980; Vestal, 1980).

Subject selection.

One of the most important considerations governing the conduct and evaluation of studies in geriatric clinical pharmacology is subject selection. If the purpose of the study is to identify a possible effect of *age* on drug metabolism or drug response, every effort must be made to choose subjects who are free of diseases and drugs which may interfere with this goal. Usually, this requires a careful history and physical examination along with appropriate laboratory tests to exclude significant occult disease, such as renal insufficiency, hepatic dysfunction, or anemia. Since renal function declines normally with age, age-adjusted criteria should be used to evaluate renal function (Rowe et al., 1976). Diet, habits and unusual occupational exposures should also be sought since these and possibly other environmental influences are known to affect drug metabolism in the elderly (Vestal, 1978). On the other hand, one might prefer to take the view that studies should be conducted in the population for which the drugs are intended, namely elderly patients with one or more diseases of interest. In this case, one is conducting a study of *age and disease* and interpretation of the results becomes more difficult. In either case, the study population(s) should be carefully described along with the selection criteria. But it is also possible that intensive screening of the population may result in a select group of super-performers whose data do not reflect the influence of age-related changes.

Cross-sectional and longitudinal studies.

Most longitudinal studies follow subjects concurrently in several age cohorts throughout the adult age range and slopes for difficult ages can be compared. Such studies are expensive and difficult to perform because they require follow-up of a stable population over a long period of time. They may also be complicated by methodological drift due to subtle changes in laboratory techniques or equipment over several years. No longitudinal studies of drug metabolism have been performed.

In the cross-sectional design, groups of various ages are studied. Only *age differences* or *effects of age*, as opposed to *age changes* or *effects of aging*, can be determined from this type of study. This distinction is important when describing the results of cross-sectional studies, since they may not relfect true age-related changes. For example, it is important to remember that subjects over age 75 come from a cohort that has experienced at least 75% mortality. If the variable under study is related to survival, a cross-sectional study will seem to show age differences that are due to the progressive loss of individuals with high values rather than aging. Thus, although there is evidence from cross-sectional studies to suggest that advanced age is associated with impaired drug metabolism, it is possible that this apparent difference between young and old individuals is the result of selective mortality rather than aging *per se*.

Protocol selection.

Since the effects of age on drug metabolism may be difficult to predict, conclusions which seem to be contradictory may, in fact, prove to be quite compatible when differences in the study protocol are considered. The dose-related hepatic metabolism of propranolol mentioned earlier in this paper is an example of such a phenomenon.

Data analysis.

If age distribution of subjects conforms best to a bimodal distribution, that is, the subjects are mainly either young or old with few or no middle-aged individuals, the application of linear regression analysis and the use of correlation coefficients to describe the data is questionable. This kind of analysis requires a bivariate normal distribution of the dependent and independent variables. If this condition is not satisfied, other statistical methods such as group comparisons should be applied to the data. If data from the middle-aged group are not available, it should not be assumed that they must necessarily be intermediate between the young and the old. They might well be similar to either the young or the old group. Also, it should be emphasized that the mere fact of a significant correlation does not necessarily imply a cause and effect relationship. It does suggest that there is an association between the variables which might be tested in a prospective manner. As noted above, it is possible that age-related variables, rather than age _per se_, may account for an apparent effect of age.

SUMMARY

1. The elderly use more drugs than younger age groups. Because of multiple diseases, older patients often require multiple drugs leading to the potential for drug interactions and adverse drug reactions. However, it is not known to what extent age per se may predispose to drug interactions. Furthermore, the toxicology of drugs in the elderly has received almost no systematic investigation. For example, are the elderly more susceptible to the hepatotoxic effects of some drugs than the young?

2. Using standardized methodology, such as the Defined Daily Dose, epidemiological studies are needed to compare drug utilization in both ambulatory and institutionalized elderly between countries and regions. This will provide the basis for the evaluation of the effects of educational programs aimed at promoting rational drug therapy in the elderly. Analysis of the differences on drug use and drug prescribing patterns in various countries, including our own, may yield insight into the determinants of those patterns and suggest optimal educational approaches.
3. Available evidence indicates that age-related alterations in the physiology of drug distribution, drug elimination, and drug action are the substrata upon which disease-related alterations in drug disposition and drug response are superimposed. Continued efforts to characterize these age-related and disease-related effects are needed. At present, generalizations are difficult because of conflicting data. Greater attention to subject selection, environmental factors, such as smoking and diet, and protocol design is necessary. As much as possible, research protocols should attempt to simulate the actual clinical use of the drug under study. This often means conducting studies at steady state after multiple dosing rather than only after a single dose. A longitudinal study using model compounds would be of great interest to help distinguish the effects of aging per se versus those of selective mortality.
4. There is a continued need for studies of age differences in drug response. Wherever possible, pharmacodynamic studies should be combined with studies of pharmacokinetics. Gaps in our knowledge exist for all drug classes.
5. Continued basic research in pharmacology and physiology is required to elucidate the mechanisms for the age differences observed in clinical studies.

This research depends on the use of animal and in vitro model systems. Efforts to define the optimal animal or in vitro model(s) for human geriatric pharmacology are obviously important components of this basic research.

6. Although compliance with therapeutic regimens is not necessarily worse in the elderly than in younger age groups, the consequences of errors in self-medication may be more severe. Thus, further efforts are needed to develop ways of enhancing the comprehension and compliance of geriatric patients.

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PHYSICIAN MANPOWER NEEDS IN GERIATRICS:
PROJECTIONS AND RECOMMENDATIONS

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There is growing recognition that, as the population ages, the physician requirements for care for the elderly segments of the population will increase. Whether one extrapolates from existing patterns of utilization or attempts to adjust for necessary improvements in the quality of care, there is a universal expectation that more and better-trained physicians will be necessary to meet the needs of the near future. There is less agreement as to how these needs ought to be met.

One school of thought, represented in the Institute of Medicine report (IOM, 1978), supports a continuation of the current heavy reliance on existing physician types (especially primary-care providers in internal medicine, general practice, and family practice). Preparation for the growing demands of elderly patients would include both more intensive training during medical school and post-graduate years for those yet to be graduated and remedial education through continuing medical education for those already in practice. In order to accomplish these training tasks, a cadre of academic geriatricians would be required, but their sphere of practice would be confined to the teaching medical centers. In fact, the training of solely academic geriatricians would produce a corps of practicing geriatricians as an inevitable by-product. Experience from other fellowship training efforts suggests a "spillover" rate into private practice of 40 to 50 percent. (Scheele and Kitzes, 1969).

An alternative formulation calls for the development of trained geriatricians capable of performing both an academic and a practice role

(Kane, et al., 1980). In the latter mode, they would serve as consultant specialists to assist in the management of complex geriatric cases with the inevitable result that they would also maintain ongoing responsibility for some subset of geriatric patients who required their care.

A third approach to the problem has attempted to estimate the need for geriatric physicians by identifying areas in which such physicians would focus their activities (Libow, 1978). Strong emphasis is placed on the nursing home and the teaching hospital for such estimates.

It is important to appreciate that all three approaches to the problem have identified the need for a cadre of better trained physicians capable of coping with the problems of the elderly patients. Whether such training can be appended to the training now being offered to primary-care physicians or whether a new entity, the geriatrician, is required may be a matter of continued debate. However, two critical elements should be borne in mind at a time when the Graduate Medical Education National Advisory Committee (GMENAC) has predicted a surfeit of physicians in virtually all areas by the year 1990, including primary care: There is consensus that additional manpower is required (at a minimum, this means a corps of academically oriented geriatricians), and there is a need for skills and motivation beyond those currently shown by the primary-care physician. It is more appropriate to talk about a redirection of physician manpower into the care of the aged.

THE PRESENT SITUATION

Drawing upon the data collected as part of a national study of physicians conducted by the University of Southern California's Division of Research in Medical Education (USC/DRME), we estimate that, in the year 1977, approximately 187 million physician visits were made by individuals aged 65 and older (including 84 million by those aged 75 and older). By the year 2030, these numbers are projected to increase, by demographic pressure alone, to 443 million and 221 million annual visits, respectively.

Data from the USC/DRME studies on encounters with elderly patients on a typical day for physicians in primary care and medical specialties are given in Table 1. As shown, primary care providers account for most of the care. Family and general practitioners provide the largest segment of nonhospital care, and general internists, the largest fraction of hospital visits. Among medical specialists, cardiologists see most of the elderly patients; dermatologists see the next largest number of outpatients; and neurologists, chest physicians, and gastroenterologists treat the next largest number of inpatients.

Conversely, data from the USC/DRME studies show that, as a percentage of total encounters, patients 65 years and older account for 35 percent of visits to internists, 35 percent of visits to family physicians (including general practitioners), and 6 percent of visits to psychiatrists. These proportions are closely approximated in data from the National Ambulatory Medical Care Survey for outpatient visits only.

One effort to provide quantitative estimates of the implications of various configurations of geriatric physician manpower has been carried out by The Rand Corporation (Kane, et al., 1981). This approach uses utilization data derived from two sources as a departure point: (1) the

Table 1

NATIONAL ESTIMATES OF PHYSICIAN-PATIENT ENCOUNTERS PER DAY, BY PHYSICIAN SPECIALITY, SETTING, AND PATIENT AGE

Physician Specialty	Nonhospital Encounters per Day				Hospital Encounters per Day			
	Number Aged 65-74	Percent	Number Aged 75+	Percent	Number Aged 65-74	Percent	Number Aged 75+	Percent
Internal medicine	56,114	32	36,522	30	46,740	48	46,076	48
General practice	75,692	43	57,048	47	22,723	23	26,869	28
Family practice	17,547	10	13,492	11	6,096	6	7,450	8
Cardiology	9,823	6	5,271	4	9,442	10	7,393	8
Dermatology	7,786	4	4,192	3	451	—	320	—
Pulmonology	1,886	1	1,043	1	2,839	3	1,520	2
Gastroenterology	1,711	1	921	1	2,415	2	1,714	2
Hematology	943	—	508	—	1,316	1	933	1
Oncology	624	—	227	—	796	1	366	1
Allergy	1,484	1	799	1	223	—	159	—
Rheumatology	971	—	523	—	498	—	354	—
Neurology	1,336	1	720	1	3,035	3	2,153	2
Endocrinology	442	—	238	—	497	—	352	—
Infectious disease	146	—	78	—	306	—	217	—
Nephrology	635	—	342	—	753	1	534	—

SOURCE: Practice Study Reports (USC/DRME data), Table 2.2.1, Board Certified and Nonboard Certified.

NOTE: Unpublished data were available for the two age intervals in internal medicine, general practice, family practice, cardiology, pulmonology, and oncology. The remaining categories were estimated by applying the average proportions of those aged 75+ (35-percent nonhospital, 50-percent hospital) of the three medical specialities: cardiology, pulmonology, and oncology for the figures available for age 65+. There was no basis from which to estimate the age distribution of encounters for obstetrics-gynecology or otorhinolaryngology.

USC/DRME data reported by physicians, and (2) the data based on various governmental reports, including the National Health Interview Survey and hospital discharge data from the National Center for Health Statistics. Because the provider-based data source and the consumer-based data source were closely reconcilable, the former was used for subsequent calculations. The method used depends upon utilization information. These data are adjusted on the basis of productivity information to develop estimates of full-time equivalents (FTEs). The steps involved in this process are summarized in Table 2. The yield in total physician visits for each time period is then distributed over various configurations of physician manpower representing three different models, which proportionately distribute separately nonhospital and hospital-based care across three classes of physicians: geriatric specialists, medical subspecialists, and primary-care physicians. These three patterns of proprotional distribution are shown in Table 3. To further explore possible alternatives, it was assumed that some of the workload of the primary-care physicians and the geriatric specialists could be delegated in varying proportions to nonphysician practitioners (i.e., physician assistants/geriatric nurse practitioners and social workers). Three different patterns of delegation were used as examples. These are shown in Table 4.

When these projections are applied to population estimates for 1977 and for representative years in the future, one gets a sense of the numbers of personnel required by the various configurations. Table 5 provides such data for the years 1977 and 2010. As reflected in the table, the burden of physician manpower required continues to rest with

Table 2

ESTIMATES OF MANPOWER NEEDS FOR GERIATRIC CARE

Recipient-Based Data

Number of geriatricians needed is a function of:

1. Number of persons in pertinent age groups (65+ or 75+) at selected dates (1977, 1990, 2010, 2030)
2. Average annual rate of utilization of services of health care providers (visits per year per person)
3. Productivity of health care providers (visits per year per provider FTE)
4. Factor for improved care

$$\text{Number needed (in FTE)} = \frac{1 \times 2}{3} \times 4$$

This equation is applied to each postulated partition of effort among types of physicians and of surrogate health care providers

Table 3

Partition (Percentage) of Effort of Health Care Personnel in the Care of the Elderly: Effect of Training Programs Aimed at Different Geriatrician Roles

Type of Training	Nonhospital Care[a]			Hospital Care		
	GS	MSS	PCP	GS	MSS	PCP
1. Status quo	1	14	85	1	19	80
2. Training geriatricians for academic positions only	—	—	—	—	—	—
3. Training geriatricians for academic positions and as consultants in practice	25	10	65	20	15	65
4. Training geriatricians for academic positions, as consultants, and as primary care physicians	40	10	50	30	15	55

NOTE: GS = geriatric specialist.
MSS = medical subspecialist (cardiologist, gastroenterologist, etc.).
PCP = primary care physician (internist, family physician, and general practitioner).

[a] Includes ambulatory care, nursing home care, and common alternatives to nursing home care.

Table 4

Partition (Percentage) of Effort of Health Care Personnel in the Care of the Elderly: Delegation of Physician Functions to Nonphysicians

Level of Delegation	Nonhospital Care[a]			Hospital Care		
	MD[b]	PA/GNP	SW	MD	PA GNP	SW
Minimal (status quo)	95	3	2	100	0	0
Moderate	65	25	10	90	10	0
Maximal	40	40	20	80	20	0

NOTE: PA/GNP = physician assistant or geriatric nurse practitioner.
SW = social worker.

[a] Includes ambulatory care, outpatient, hospital, nursing home care, and common alternatives to nursing home care.

[b] Only GS and PCP are assumed to delegate. MD refers only to nonsurgical physicians.

Table 5

NUMBER OF PHYSICIAN PERSONNEL (IN FTEs) NEEDED IN 1977 AND 2010 TO CARE FOR PERSONS 65 YEARS AND OLDER AT CURRENT UTILIZATION LEVELS

Mode of Geriatric Practice	Number of Physician Personnel Required					
	1977			2010		
	GS	MSS	PCP	GS	MSS	PCP
Status quo	432	730	22,772	655	1,109	34,453
Consultative	9,915	5,484	17,808	15,000	8,330	26,953
Primary care	15,509	5,484	14,214	23,452	8,330	21,527

NOTE:
GS = geriatric specialist.
MSS = medical subspecialist.
PCP = primary care physician (i.e., general internist, family physician, and general practitioner).

the primary-care physician for the model based on the current distribution (status quo) and if the geriatrician operates in the consultative mode. As the geriatrician takes on increasing primary care responsibilities, the burden of care is more equally shared between the geriatrician and the primary-care physician. The differences between the relative proportions of manpower shown in Table 5 and those shown in Table 3 are attributable to the lower productivity estimated for the geriatric specialist compared to a primary-care physician.

There is some reason to believe the appropriate target for geriatric care should be more realistically set for those over the age of 75 as opposed to the conventional wisdom of using age 65 as a definition of the onset of old age. One can make similar projections for this older age group. An example for the year 2010 (to permit comparison with Table 5) is shown in Table 6. Here the proportions of FTEs remain similar to the previous table, but the numbers of physicians required are somewhat reduced, commensurate with the smaller population to be served. However, because persons over the age of 75 use substantially more care than do those over the age of 65, the numbers remain impressive.

An alternative source of manpower to share the medical care burden of the elderly is the geriatric nurse practitioners/physician assistants and social workers alluded to earlier. Table 7 displays the effects of redistributing this care for the same year (2010) under two patterns of delegation. It should be noted that each pattern of delegation does not produce a commensurate reduction in the level of physician manpower necessary because the productivity levels of the nonphysician providers are estimated to be only about 60 percent that of physicians.

Table 6

NUMBER OF PHYSICIANS (IN FTEs) NEEDED IN 2010 TO CARE FOR PERSONS 75 YEARS AND OLDER AT CURRENT UTILIZATION LEVELS

Mode of Geriatric Practice	Number of Physicians Required		
	Geriatric Specialist	Medical Subspecialist	Primary Care Physician
Status quo	335	577	17,441
Consultative	7,587	4,357	13.688
Primary care	11,823	4,357	10,987

Table 7

NUMBER OF PHYSICIAN AND NONPHYSICIAN PERSONNEL (IN FTEs) NEEDED IN 2010 TO CARE FOR PERSONS 65 YEARS AND OLDER AT CURRENT UTILIZATION LEVELS UNDER TWO LEVELS OF DELEGATION

Mode of Geriatric Practice	Number of Physician and Nonphysician Personnel Required									
	Moderate Delegation					Maximal Delegation				
	GS	MS	PCP	GNP/PA	SW	GS	MS	PCP	GNP/PA	SW
Status quo	520	1,109	26,914	11.622	3,766	391	1,109	19,352	19.479	7,532
Consultative	11,702	8,330	21,156	12.169	3,941	8,518	8,330	15,692	20,398	7,882
Primary care	18,205	8,330	17,026	12,169	3,941	13,329	8,330	12,739	20,398	7,882

NOTE:
GS = geriatric specialist.
MSS = medical subspecialist.
PCP = primary care physician (i.e., general internist, family physician, general practitioner).
GNP/PA = geriatric nurse practitioner or physician assistant.
SW = social worker.

It should be emphasized that each of these displays is not intended to produce an exact number of physician equivalents needed to provide care under any of the conditions but rather to estimate the approximate quantitative implications of alternative solutions. These arrangements represent admittedly arbitrary proportionate distributions of effort and should be taken as only indicative points along a more continuous spectrum. Nonetheless, several conclusions emerge:

1. There is going to be a need for substantial numbers of physicians with the requisite skills to provide care for the elderly.
2. If any substantial proportion of those physicians are to be trained geriatricians, the programs must be initiated at once to begin to meet this manpower demand.
3. Even the most conservative estimates suggest a deficit in geriatric manpower when compared to the current productivity rates of training programs now underway that yield far less than 100 graduates per year when fully operational.
4. Even if we take the most extreme model, which calls for the geriatrician to deliver primary care, there will still remain a substantial burden of care on the shoulders of primary-care physicians and medical subspecialists. Training programs to adequately prepare these physicians require immediate attention.
5. If we were to rely on nonphysician providers for any proportion of the care of the elderly, similar programs must be developed at once to graduate such trained professionals.

In light of the recent GMENAC projections of a physician surfeit by 1990, even in primary care disciplines (GMENAC, 1979), it is important to emphasize that the projections of geriatric medical manpower needs dc not imply any increase in the number of physicians to be trained. The choice of using full-time equivalents was deliberate. It allows one to speak in terms of re-directing present and future manpower away from the glutted specialties into geriatrics. We re-emphasize that we are not calling for more physicians, but for differently prepared physicians. As shown in Table 8, GMENAC forecasts a surplus of more than 6,500 primary-care physicians in general internal medicine and family practice and almost 18,000 internal medicine sub-specialists. (Additionally, a surfeit of 4,950 pediatricians is also predicted.) Were even a proportion of those in training for these specialties re-directed into geriatric training, much of the projected deficit could be met. Thus, our recommendations are generally consonant with those of GMENAC (although we take some exception to the way in which they estimated the manpower needs to care for those age 65 and older).

We emphasize that the effects of our proposed changes would be to redistribute physician workload. No new physician manpower is required beyond those already projected by GMENAC. In fact, the redistribution we envision would alleviate some of the problems GMENAC has predicted. The general sense of our proposal is shown in Figure 1. We anticipate a growth in the total need for services between 1980 and the year 2000 due to the growth in the elderly population. Adding a corps of geriatricians would reduce the geriatric workload of primary-care

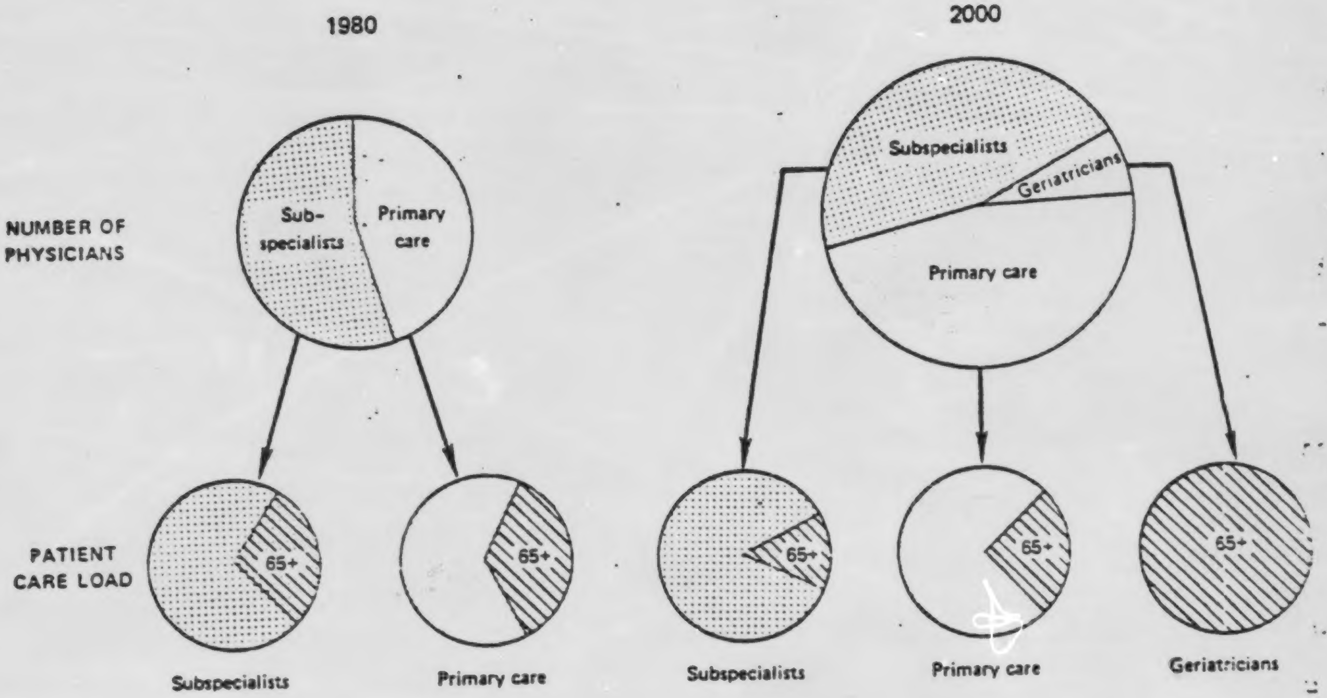
1980
2000
NUMBER OF PHYSICIANS
Sub-specialists
Primary care
Subspecialists
Geriatricians
Primary care
PATIENT CARE LOAD
65+
65+
65+
65+
65+
Subspecialists
Primary care
Subspecialists
Primary care
Geriatricians

Figure 1: Effects of Proposed Redistribution of Physician Manpower to Include Geriatricians

physicians and specialists; but, because the geriatricians would come from this pool of physicians, no overall shift in the numbers of physicians is required.

All of the projections presented so far assume that we would be offering care at the current levels of utilization. Our estimates suggest that there is presently a shortfall of approximately 25 percent if we want to provide care equivalent to that provided for other sectors of our society. The major component of this deficit is in the reduced encounter time between doctors and older patients. Generally speaking, regardless of the type of visit or the training of the physician, the older the patient, the less time the physician spends with him. It is safe to estimate that all of the figures presented could be more accurately portrayed as representing improved medical care if they were 125 percent of the numbers presented.

Thus, regardless of the final model chosen, there is an immediate need for a substantial cohort of academically based geriatricians who will serve as the educators for future generations of physician and nonphysician providers to care for the elderly. We turn our attention now to the question of how many of these indivdiuals will be required.

ACADEMIC GERIATRICIAN NEEDS

The consensus about the need for academic geriatricians led us to estimate the need for this group of faculty, using two different methods. As shown in Table 9, the first method provides an upper-bound estimate. It represents a relatively straightforward approach in which 2 FTEs of faculty are allocated for each internal medicine residency program, and 1.5 FTEs are allocated for family practice training

Table 9

ESTIMATED NEED FOR ACADEMIC GERIATRICIANS

1. Upper-bound estimate	FTEs
A. Residency Training	
2.0 faculty, internal medicine residence x 328 programs	656
1.5 faculty, family practice residency x 230 programs	345
2.5 faculty if both in one hospital x 128 hospitals	320
Subtotal	1321
B. Medical student training	
3 FTE per medical school x 124 school	372
less economies of scale where residency programs are located in primary university hospitals	(90)
Subtotal	282
Upper-bound Total	1603
2. Lower-bound estimate	
A. Residency training	
(1) Internal medicine	
0-9 FT faculty and 0-29 residents at 0 FTE x 190 programs	
10-19 FT faculty and/or 30-49 residents at 1 FTE x 85 programs	
20+ FT faculty and 0-29 residents at 1 FTE x 23 programs	
0-9 FT faculty and 50+ residents at 1 FTE x 2 programs	
20+ FT faculty and 30+ residents at 2 FTE x 4 programs	
10+ FT faculty and 50+ residents at 2 FTE x 5 programs	
20+ FT faculty and 50+ residents at 2 FTE x 147 programs	
Internal Medicine Subtotal (456 programs)	422
(2) Family Practice	
0-3 FT faculty and 0-17 residents at 0 FTE x 126 programs	
4-6 FT faculty and/or 18-29 residents at 0.75 FTE x 134 programs	
7+ FT faculty and 0-17 residents at 0.75 FTE x 4 programs	
0-3 FT faculty and 30+ residents at 0.75 FTE x 8 programs	
7+ FT faculty and/or 30+ residents at 1.5 FTE x 44 programs	
4+ FT faculty and 30+ residents at 1.5 FTE x 19 programs	
7+ FT faculty and 30+ residents at 1.5 FTE x 23 programs	
Family Practice Subtotal (358 programs)	238
Less economies of scale due to coexisting programs	(12)
Residency Training Subtotal	648
B. Medical student training (as above)	372
Less economies of scale where residency programs are located in primary university hospital	(131)
Subtotal	241
Lower-bound Total	889

programs. Some economy of scale is represented by the allocation of 2.5 FTE if both internal medicine and family practice residencies are located in the same hospital. This approach estimates a total need for approximately 1300 faculty for primary-care residency training. In addition, we have estimated that a minimum faculty cadre of three FTEs per medical school is required to mount even a modest geriatric training program. This would include faculty required for fellowship training and the training of other types of health professional students. Where medical school programs are located with residency programs, we allowed for some economies of scale, resulting in a total need for approximately 280 faculty for medical student training. The upper-bound total, then, is 1603 FTEs of geriatric faculty.

The alternative method, which leads to a lower-bound estimate, makes more specific calculations for faculty needs for residency training on the basis of the size of the full-time faculty currently present and the number of residents. Using this technique, we have allowed for 0 to 2 FTEs for residency programs in internal medicine and from 0 to 1.5 FTEs for residency programs in family practice. This approach would yield a total of 517 FTEs of geriatric faculty for residency training programs; to this we added 372 FTEs for medical student training. Because we have been more modest in our estimations of faculty needs for residency training, we did not use the economies of scale for the medical student training in this method. The lower-bound estimate, then, is 889 faculty. It thus seems safe to conclude that one would need at least of 900 faculty to provide a minimal staff for medical schools and other health professional training as well as resident training in internal medicine and family practice.

These 900 faculty would participate in the full range of academic pursuits. We estimate that approximately 25 percent of their time would be spent in clinical activities that would proportionately offset the need for practicing geriatricians using the techniques previously estimated. In addition, we estimate that a further 25 percent of their time would be spent in research pertinent to geriatric concerns. Table 10 shows some of the estimated geriatric research manpower needs. Here we add our estimates of 900 to 1600 FTEs of academic geriatrician manpower to an estimated need for approximately 450 academic geropsychiatrists in order to provide minimum staffing for psychiatric training programs, for a total of approximately 1400 FTEs. Clearly, 25 percent time will not be sufficient to undertake meaningful research in an area just beginning to develop.

One compromise is to anticipate that heavy use will be made of doctoral-level researchers in related fields (basic and applied). At a minimum, we foresee the need for at least one doctorally prepared researcher to work with each academic geriatrician. Such dyads imply a total research FTE complement of 1700 to 2500 persons capable of doing research in geriatrics. The estimated need for some 2000 doctoral-level researchers in aging can be contrasted to the 453 graduates supported by NIA (or its predecessor, NICHD-ADAB) between 1965 and 1975 (272 received predoctoral support and a slightly overlapping 194 received postdoctoral support). Of these, approximately two-thirds have remained in academic work related to aging. Extrapolating from limited data points, there is cause for modest optimism. Whereas only about one-fifth of the 453 graduated before 1970, about one-half graduated between 1972 and 1975 (Speith, 1978).

Table 10

ESTIMATED GERIATRIC RESEARCH MANPOWER NEEDS

	FTEs
Academic Geriatricians	889-1603
Academic Geropsychiatrists	450
Total	1339-2053
Research Geriatrician FTE @ 25%	335-513
+ 1 Doctoral-Level Researcher per Geriatrician	1339-2053
Total Research FTE	1674-2566

But, as we have already noted, such a compromise will not suffice to establish geriatrics as an academic peer with the more established disciplines. The lessons of other newly arrived fields in academic medicine (like family practice) should be appreciated. The tasks of developing clinical and teaching programs extract a great price from the first generation of academic practitioners. Unless active efforts are undertaken to prevent it, research and other scholarly activity is relegated to a lower priority in the press to mount new programs. Only when the academic crisis occurs about questions of promotion or credentials is the deficiency actively acknowledged and hasty remedial efforts launched.

In the case of geriatrics, which cannot draw upon the wisdom of extant practitioners, the loss is doubly severe. Not only are we concerned with the nuturing of academic geriatricians, we are also sensitive to the great need for new and better information about the clinical problems faced by the growing number of elderly in this country. An academic geriatrician cannot make sufficient progress in research on these complex problems with only 25 percent of his time available.

In addition to the doctoral-level researchers already accounted for, physician researchers trained in the techniques of biomedical research are necessary to provide a working bridge between the laboratory and the geriatric clinic. We estimate that, at a minimum, an average of two such academic geriatrician biomedical faculty are needed today to make progress in geriatrics possible. We recognize that these 250 physicians may not be equally distributed across all institutions, but the total number will likely fall in this range. Mechanisms must be developed to recruit, train, and reward such persons if we are to find new answers to geriatric problems and to re-examine the answers currently promulgated.

RESEARCH

The scope of research by geriatricians should be as broad as possible. In a burgeoning field such as geriatrics, there is a need for research at all three levels, including basic (or biomedical) research, clinical research, and health services research. The Institute of Medicine report has identified a number of areas in which major breakthroughs in basic research are indeed possible. These would include the areas of immunology, mechanisms of aging, basic studies in physiology, neurology and neuropathology, endocrinology, and the like. More extensive discussion can be found in recent comprehensive reviews of research opportunities published by the NIA (National Institute on Aging, 1978, 1979).

The repertoire of potential clinical work to be done in geriatric research is almost boundless. There is a need for careful clinical trials of a variety of therapies, including drug therapies and the use of new kinds of milieu interventions. In the area of health services research, better work is needed to develop new techniques for appropriately assessing the variety of geriatric problems in the development of new taxonomies. We need to look at new configurations of care, exploring such techniques as the geriatric assessment unit. Geriatricians are sorely needed to develop more effective methods of giving care within the nursing home, to experiment with new records-keeping systems and more effective use of teamwork. Better linkages between the nursing home and other parts of the long-term care (LTC) spectrum and between the LTC spectrum and the acute medical care system should also be explored.

BIOMEDICAL RESEARCH

The issues in this section are directed at increasing our understanding of the basic processes of aging and advancing our knowledge of the clinical manifestations of aging as steps toward the prevention and control of its undesirable manifestations. The overall objective of biomedical research in aging should be to reduce the incidence of chronic disease and disability and to lengthen life to the limits of man's biologic heritage, assuring that this lengthening will be associated with a healthier existence.

Many of the diseases and disabilities of later life appear to be secondary to the action of environmental agents--be they nutritional, traumatic, and/or toxic--upon an organism that is becoming increasingly vulnerable because of the aging process. Thus biomedical research directed at the fundamental biology of aging addresses the etiologies of this increased susceptibility. If these causes are understood, efforts can be directed at producing a physiologically younger organism more resistant to disease, especially the degenerative diseases. A decrease in late-life disease and disability would result in a prolongation of presently established life spans.

We offer here a blueprint for the next decade's biomedical research in aging based on four organizing concepts: (1) life-maintenance processes and regulatory systems; (2) programmed senescence (the biologic clock concept); (3) basic biology of human aging; and (4) pharmacological interventions. This list does not pretend to be exhaustive. The illustrations are intended primarily to underline the exciting possibilities and to demonstrate the importance of such discoveries for our management of age-related illness.

Life-Maintenance Processs

These concepts encompass integrative biochemistry, physiology and systems analysis. We offer several examples:

1. The DNA repair systems. The life span in different species ranging from 3 years in mice to the biblical 120 of man shows a striking correlation with the level of DNA repair capacity of the species. Each organism's DNA suffers damage as a concomitant of aging, and cells possess enzymes that identify and attempt to correct this damage. The ability to accomplish repair correlates with maximum life span and, to some extent, with resistance to disease. In lower organisms, life span can be prolonged by artifically increasing DNA repair capacity. Thus an analysis of DNA repair mechanisms and related studies in chromatin would contribute substantially to our understanding of the biology of aging.
2. "Free radical" scavengers. By-products of oxidative metabolism are toxic, and cellular mechanisms have been developed for scavenging or eliminating these "free radicals." It is

postulated that "free radical" damage may be one of the chief features of aging. Administration of free radical scavenging agents to mice can prolong average life span and (to a lesser extent), maximum life span, and diminish susceptibility to disease.

3. Immune system. The immune and endocrine systems, including the neuroendocrine system, are important life-maintenance and regulating systems. Although both undergo highly significant changes with aging, these changes have been best documented in the immune system. Both may, in fact, be pacemakers for the aging process. The normal immune response capacity declines with age to 10 or 20 percent of its peak youthful value, and the tendency of the immune system to react against itself in a self-destructive process increases markedly. The evidence for involvement of the immune system in aging includes the following: (a) involution of the thymus, an organ essential for generating normal immune responsiveness; (b) substantial shortening of the life span and presence of aging-like features in certain autoimmune susceptible strains of mice; (c) presence of features of accelerated aging in certain human diseases in which immune dysfunction is demonstrated (e.g., Downs Syndrome); (d) in advanced age, the frequency of human and animal diseases such as cancer that may involve a compromised immune response. The age-related features of the immune system appear to underlie a major portion of the enhanced disease

susceptibility of old people. Accumulating evidence supports the possibility of attaining considerable rejuvenation of an aging immune system; this will be addressed further in the section of pharmacology.

4. The endocrine system. Neurological and endocrine functions decrease substantially with age. Our understanding of this phenomenon in the case of neuroendocrine functions has been greatly enhanced by recent recognition of new neurotransmitter substances, including the neuropeptides. Research in this area of neurobiology may lead to an understanding of some of the major problems in human aging ranging from dementia to the affective disorders. In addition, advances in our ability to measure and even intervene to a limited extent in hormone production and changes in peripheral tissues hormone receptions have rendered these processes amenable to detailed study.

Programmed Senescence (Biological Clock Concept)

It is well established that animal and human fibroblasts and human lymphocytes will undergo only a limited amount of proliferation in tissue culture. Thus aging may result from a physiological clock system within each cell or from a central system such as the nervous system. The program may be stored in genes; aging may be viewed as a process of development, involving gene repression and derepression as occurs in earlier periods of the life span. The only type of cell that escapes senescence in culture is the "transformed" or cancer cell. The phenomenon of transformation has been poorly studied from the gerontologic point of view. It may reflect differences in only a few genes. Preliminary evidence suggests the cell clock may be genetically linked to the major histo-compatibility complex. Further studies aimed at localization of the clock genes deserve high priority.

The possibility has been raised that the "senescence genes" are turned on in late life through gene derepression. The possibility of identifying specific senescence genes and counteracting them (or of preventing the derepression) is an exciting area of investigation.

Basic Biology of Human Aging

The basic biology of aging in humans deserves intensive study using the newer techniques of cell culture and ctyo- and biochemical genetics. Such programs concern themselves with normal humans from age 20 to 100+. Particular attention should be directed at various cellular components of the blood that are readily available for analysis. These efforts should be directed toward identifying "biological markers" of aging that could permit a comparison of physiologic and chronlogic age in humans. Such information would greatly facilitate assessing the efficacy of interventions aimed at correcting or mitigating the derangements of the aging process. If, for example, potential age-altering agents become available in the future, evaluation of their effects could take place over a two- to three-year period rather than over many decades as now required.

Pharmacologic Interventions

Conceptually, the interventions range from immunopharmacology through neuropharmacology to cellular or genetic engineering. Considerable rejuvenation of the aging immune system has been achieved by using thymic hormones, prostaglandins, cell transfer (i.e., bone marrow or thymic tissue transplantation), nutritional manipulation and more traditional pharmacologic agents. Nutritional manipulation in the form of caloric restriction accompanied by specific diet supplementation produces the most dramatic effect on disease pattern in life span. In experimental rat and mouse colonies, restriction beginning either at weaning or at mid-life can increase maximum life span by 25 to 100 percent and can sharply curtail cancer and vascular disease incidence. This nutritional intervention is cited as an example of a panoply of interventions in the aging process.

Recruitment, training and retention of future faculty leaders in geriatric activities require an associated activity in research related to the aging process. We have attempted to identify some promising areas for study, selected because they demonstrate the broad scope of disciplines that need to be employed. It is eminently clear that the areas for research greatly exceed the pool of competent investigators now available. Major efforts to enhance both research and education are crucial to the development of adequate future faculty in geriatrics.

HEALTH SERVICES RESEARCH

Perhaps one of the greatest social challenges facing us into the next century is the delivery of effective care for the aged. Progress toward this goal will require the integration of knowledge and energy from a variety of resources, not the least of which is the research community. In conjunction with work toward advancing our understanding of the basic mechanisms of aging and efforts to alleviate their disruptive consequences we will need equal efforts directed toward the development of better means for delivering care to the aged. This latter work falls within the general sphere of what has been termed health services research (HSR).

The boundaries between health services research and clinical research are not always clear and are even less often important. There are certainly stages in the development of an idea for improving care that progress from a theoretical construct of a basic mechanism to a clinical application with demonstrated efficacy and finally on to a new mode of practice with proven effectiveness. The usual concerns of HSR are focused on the latter phase, but often these concerns spill over into more proximate steps.

As we look toward the development of new services and new personnel, we must anticipate the testing of proposed innovations to establish both their efficacy and the exent of their impact on the groups targeted and on other parts of society. HSR can make a major contribution to the care of the aged. Although a full listing of potential agenda items is bounded only by one's imagination, several topics appear particularly pressing. We will discuss each briefly to present a sample agenda for future research and to illustrate how HSR can contribute to our understanding of the problems.

The evaluation of any planning strategy directed at altering the health status of the elderly by changing the availability or skills of geriatric providers requires a technology for assessing that health status initially and detecting increments of progress. Efforts to train geriatricians or "gerontologized" practitioners require accurate and appropriate assessment tools that can be introduced through the educational process.

The subject is topical and complex. Assessment has become a buzzword in geriatric policymaking groups. A comprehensive, individualized assessment of the elderly person's functioning has been proposed as the open-sesame for access to expanded LTC benefits. Once services have been marshalled on behalf of the individual, program accountability also depends on regular assessment of the program recipient. Integral to this process is an ability to make accurate measurements of factors selected as important. Unfortunately, no agreement has yet been achieved on two of the most crucial points: (1) the identification of important factors to be measured, and (2) the technology for making these measurements.

Beyond a need for technical knowledge and skill derived from the medical subspecialties relevant for treatment of particular problems, those caring for the elderly require a general perception about the well-being of the older person that transcends a particular diagnosis, problem, or specialization. Many authorities have pointed out the limitations of a diagnosis-centered approach in viewing the health of the elderly (Kent, Kastenbaum, and Sherwood, 1972; Sherwood, 1975; Goran, et al., 1976). Conventional wisdom now holds that (1) the elderly are subject to multiple diagnoses; (2) the physical, mental and social well-being of an elderly individual are very closely interrelated, so that multidimensional assessments of health status are necessary; and (3) measures of functional status that examine the ability to function independently despite disease, physicial and mental disability, and social deprivation are the most useful overall indicators to assist those caring for the elderly.

Where does this leave the physician or other health care provider? The mandate for a global assessment of functioning presents a formidable and elusive task. The clinician needs practical tools that will permit evaluation of the individual's status, prediction of his future course, and planning for his care. In a way, measurements are organizers, capable of turning amorphous and expansive goals into a series of defined tasks. They are the means by which progress or lack of progress is noted. The bad image of geriatrics in the eyes of the neophyte physicians may be partly attributed to a perception that the patients are not amenable to change in status. To dispell such notions, physicians can be equipped with accurate and trustworthy techniques to help focus their attention on the postive changes that are indeed possible (Kane and Kane, 1981).

In some cases, scales and measurement systems have been developed, validated, and proven reliable by widespread use in psychological and other experimentation. These need only be adapted for geriatric use. In most instances, however, measurement techniques need to be refined or new measures developed. Such work requires that each component be evaluated and that the entire instrument then be tested for accuracy, validity, reproducibility, and reliability.

The development of measures requires the participation of psychometricians; such personnel may need to be attached to geriatric units so that the developmental work will proceed within the context of LTC delivery. Although physicians would not be expected to bear the brunt of this initial work, they will have important contributions to make. The evaluation of the impact of programs requires these tools and so, too, do clinicians monitoring the outcomes of their treatment. Furthermore, before the interaction of physical, mental, and social outcomes can be studied, each construct must be amenable to separate measurement.

Effectiveness of Care

Once measurement capability has been established, geriatricians can begin to examine the effectiveness of treatment. The effects of clinical regimens and of various patterns of care delivery can then be studied. The investigators would have the opportunity to show empirically to what extent the overall goals of LTC (e.g., survival, independence, contentment, freedom from discomfort, mental alertness) are compatible with each other and to what extent tradeoffs are necessary among goals.

The other side of effectiveness is iatrogenesis, and this, too, requires investigation. Because the elderly require a disproportionate amount of diagnosis and treatment, one would expect them to be vulnerable to a commensurate number of iatrogenic complications. Quantitative and qualitative assessment of the contribution of medical iatrogenesis to the disabilities of the elderly is an important research topic. We need to know to what extent medical interventions lead to a worsening of patients' conditions. In test populations, stratified to encompass common diagnoses and a wide range of functional status, one could assess what fraction of episodes of relatively sudden decline in health status are primarily or secondarily associated with medical procedures (such as drugs, treatments, or surgery). One could also assess the risk/benefit ratio for therapy, a parameter at least considered in younger persons, but rarely in the elderly.

Although medical interventions for the elderly are assumed to be fraught with danger (adverse drug reactions, for example, occur more frequently than in younger people), it is uncertain whether these reactions are due to inherent susceptibility or poor compliance (perhaps produced by a combination of decreased memory and complex regimens). A useful series of studies could be designed to determine whether medical iatrogenesis is a major or a minor element in the overall health picture of the elderly and what proportion of it is attributable to patterns of care or other provider characteristics. Models for experiments in related areas are available to aid in the design of such studies (Jick, 1977).

A more subtle dimension of the iatrogenesis question concerns the effects of the general patient-management decisions made by geriatric providers. Elderly persons have been known to manifest marked losses in functional ability, including declines in mental status, when moved to an unfamiliar environment. Seligman (1975) has termed this phenomenon of withdrawal and apathy among institutionalized individuals "learned helplessness." Disorientation is likely to be greater in unfamiliar surroundings. Rigid routines may leave the patient with aggressive, sometimes even abusive, behavior as the only means of self-expression. If referral to a nursing home is made as part of a recuperative process, this, as well as the drug or surgical procedure under study, might contribute to functional decline. This emotionally charged issue is susceptible to dispassionate objective study.

Clinical Epidemiology

Many of the issues relevant to geriatric practice can be approached from an epidemiologic perspective. We might begin with some very basic questions. For example, what are the problems that account for most of the hospital admissions among the elderly or for most of the LTC days? Such questions are not readily answered, and the answer to each part of this question may be quite different. Unfortunately, neither answer is likely to be readily available from the medical record. Such a comment is not a criticism of recordkeeping, but a recognition that most clinicians do not carefully identify precipitating events. For example, rarely does the clinician note the factors surrounding the fall that led to a fractured hip.

The cursory data available suggest that a few common problems account for a substantial proportion of the difficulties. For example, the most frequent causes for admission to geriatric wards in Britain are falls, strokes, incontinence, and mental confusion (Isaacs, Livingstone, and Neville, 1972). These causes present us with multiple research opportunities in both clinical research and health services research. The clinical researcher might study cardiac arhythmias that affect cerebral blood flow or explore problems in proprioception and balance. The health services researcher might investigate how the organization of services and the service delivery environment exacerbate or ameliorate these problems. We have already noted the likelihood that many treatments and procedures are not necessary. Similarly, the routines of the short-stay hospital may need altering for the elderly. If a geriatric patient spends three weeks without being dressed and allowed out of bed, the effects on functional abilities could be grave. As these examples suggest, geriatricians need to develop information about social and environmental factors correlated with the incidence and prevalence of common geriatric problems.

Research into these common problems of geriatrics offers an opportunity to combine the interests of the clinician and the health services researcher. For example, who is at risk from falls (or incontinence)? What are the circumstances associated with these untoward events in terms of physiologic phenomena (e.g., arrhythmias or hypotension in the case of falls), activities, and precipitating events? How effective is the therapy intended to rehabilitate those who fall (e.g., physical therapy)? Settings such as the VA offer an excellent opportunity for this type of research, although limited in generalizability by the special male population served. Because of their large identifiable and traceable population, prospective studies can be considered. Long-term follow-up is quite feasible, thus permitting analysis of patterns of recurrence and comparison of treatment goals to actual outcomes. Treated groups can be compared with untreated or alternatively treated controls.

Imagination in the design of the environment of LTC patients and their routines may pay great dividends. Architectural design can provide ready availability of toilets to lessen incontinence. Reminders can often prevent soiling. Once again, more quantitative data on the relative efficiency of a unit designed and staffed to help patients function most effectively would be useful. Can such a unit save more than its marginal cost by reducing length of stay, using fewer and less-trained staff, and reducing staff turnover?

Toward Prognostic Indicators

Once outcome measures are clearly established, controlled clinical trials of various methods of managing elderly patients can be fielded and the effects measured in terms of physical, mental, and social functioning. Such trials are appropriate when genuine doubt exists about the relative merits of alternative approaches to an end that is clearly valued by the patient population. It is worthwhile, for example, to test the ability of geriatric assessment units to maximize the patient's possibility of returning to the community or the extent to which geriatric day hospital attendance is associated with improved functional status. For studies such as these, randomized assignment to various experimental (and control) conditions is both sorely needed and ethically justified when (1) resources are scarce so that there are more candidates for geriatric assessment units or day hospitals than could presently be served, and (2) the effects of the care are uncertain. If care in specialized geriatric units was associated with decreased independence or well-being, one would not wish to proliferate their development. If, on the other hand, the services were beneficial, their expansion would be warranted. Similarly, controlled clinical trials can be used to test the marginal benefits of increments of service, e.g., adding home visits of occupational therapists or adding counseling services.

Many times, however, controlled clinical trials are not appropriate for ethical or logistic reasons. Then the effect of services can be judged only in comparison with some reasonable prognosis of outcome for the particular case. This suggests a line of research directed at establishing average prognoses for conditions common to the elderly. (Although this technique is applicable to chronic disease in general, it has special relevance for the elderly where advanced age may be an important factor.) Prognoses for LTC patients with varying conditions must be established along the dimensions of all the important goals of geriatric care. Such work is a laborious but inescapable methodologic requirement for further studies of the elderly because it provides a basis for comparing outcomes of alternative treatment when randomized trials are not feasible.

In brief, elderly patients must first be classified according to a well-organized system of diagnosis and staging. Then a team of experts could make prognistic estimations related to goals of care, using temporal targets (such as three months, six months, or one year). The actual health status of each patient can be determined at each agreed-upon point and compared with the original prognosis. Ultimately, when a set of reliable prognoses has been determined, these can be recorded and codified. Mathematical modeling can be used to identify those factors most useful in prediction. Such a process would be repeated until a sufficiently high level of predictive accuracy is achieved. The goal is to reduce such predictions to average prognosis statements, which can be applied to various populations with defined characteristics. Numerous iterations are needed to produce workable formulae for estimating such averages.

The result of these efforts is equivalent to a natural history for a group of patients with specified characteristics. This information provides a probability estimate of the role of change from one status to another, an estimate that offers a critical contribution to any efforts to describe decision-trees for patient care (Kane and Kane, 1980).

Once available, average prognoses have ready application to many studies. For example, they can be used to determine whether monetary or other incentives to caretakers can lead to better outcomes than the standard prognoses. Another use would be to compare the cost and effectiveness of various configurations of health care personnel. Two existing studies have indicated that geriatric nurse practitioners working with a physician can provide satisfactory primary care in nursing homes (Kane, et al., 1976; Master, et al., 1980). In one of these studies, a social worker also made a significant contribution to the outcome (Kane, et al., 1976). In neither study, however, were medical psychological, or functional outcomes estimated and compared with a suitable control population of known average prognosis. Patients were not classified according to levels of necessary care, nor were several permutations of team health care assessed. Thus, much remains to be done before these crucial questions can be answered.

Similarly, studies are needed comparing effectiveness and cost of various configurations of living conditions and health care setting. Alternatives to nursing home placement (e.g., home care plans or home-care-plus-day-care centers or residential communities with specialized services available) are often suggested. The literature contains hints, however, that such plans may, indeed, be significantly more expensive than nursing home care (Weissert, Wan, and Livieratos, 1980). Whether they are correspondingly more effective than nursing home care is not clear. We could rephrase this question to ask whether the average outcome is better than standard prognoses for patients in various levels of initial status. The experimental design to address such questions is self-explanatory.

A major development in the field of LTC is the growing emphasis on case management. Data from the GAO study in Cleveland have suggested that it is possible to classify both the care needed by and the services rendered to a population of elderly individuals. These can then be combined in a matrix. Further analyses can calculate the rate of change over time that can, in turn, be related to the care received (U.S. Comptroller General, 1977; Maddox and Dellinger, 1978). This study used a taxonomy of services rendered that was sufficiently encompassing to include a wide variety of medical and social services. Longer periods of followup would permit more precise calculations of the probabilities of an elderly individual's going from one status to another.

Community-based programs have been funded on a demonstration basis to test the benefits of a comprehensive assessment as a basis for patient planning in settings other than the nursing home. Two of the best known programs, ACCESS in Rochester, New York, and TRIAGE in Connecticut, combine the assessment and placement functions with recurrent monitoring to assess the appropriateness of such placements. Again, questions could be phrased in terms of comparing the average outcomes with standard prognoses.

Prevention

Much attention has been devoted recently to identifying methods for preventing disease and disability among the elderly. Unfortunately, such discussions tend to be rather careless in the references to prevention. It is not always clear when one is addressing programs designed to prevent illness in the elderly and when the prevention is intended to reduce the future need for extensive care, especially institutionalization. Although these two goals are related, they may employ quite different strategies.

Discussions of prevention are traditionally divided into primary and secondary prevention. The former refers to interventions designed to remove environmental hazards or to render a person less susceptible (e.g., immunization). Secondary prevention deals with detection of disease before it becomes symtomatic to facilitate earlier intervention; this approach generally falls under the heading of screening.

Health services research is needed across the spectrum of prevention. Programs are currently underway to explore the effects of early intervention of a variety of services on vulnerable elderly in the expectation that this will delay or avoid the need for institutionalization. More work is needed to identify the appropriate populations toward whom to direct such activities. A population of essentially well persons will have so low a probability of institutionalization that early treatment could not have a substantial effect. A more severely impaired population may require too many services to be affordable. HSR can provide insight into the steps necessary to target these services most effectively and into the range of benefits that will accrue for the various subgroups identified.

At the level of clinical prevention, there is growing interest in increased use of vaccines for both viral and bacterial diseases. Controlled trials of these vaccines are needed lest we are forced to rely on more inferential studies (Broome, Facklam, and Fraser, 1980). There are good reasons for anticipating that appropriate immunizations will be cost-beneficial in the elderly (Williams, et al., 1980). The elderly have a high rate of disease, both acute and chronic, and thus represent a susceptible population. Because the effects of prevention are often delayed, investments are analyzed in terms of discounted dollars; the elderly do not extend the period of effect so far into the future as to errode savings through inflation. At the same time, there is cause for caution. The elderly's compromised immunological response may impede the effects of the vaccine. Those most at risk may be the hardest to reach. The vaccine may be inappropriate or produce serious side effects (e.g., the swine flu vaccine). Such considerations call for careful trials.

Enthusiasm is similarly building for efforts directed at early detection of disease (Breslow and Somers, 1977). Because the total pool of resources for the elderly is constrained, difficult decisions must be made about what areas to emphasize. There is an intuitive appeal in an ounce of prevention, but no guarantee of a 16 to 1 return on the investment. There is some basis for fearing that screening may actually have a negative effect by uncovering problems for which no effective treatment is available. In those circumstances, early detection raises anxiety without cause. The criteria for useful screening tests have been defined by various groups (Wilson and Junger, 1978). Recently a thorough review of information on early detection concluded that the extent of empirical evidence based on scientific trials was insufficient to offer clear guidelines (Canadian Task Force, 1979). Perhaps nowhere is this more the case than with the elderly. Careful trials are needed to identify those areas where early detection can alter the course of an illness. Data are needed to explore the effects of large scale screening projects on a population. Should such screening be done and, if so, how frequently? Combined efforts of epidemiologists, economists, and geriatricians are needed to understand the course of illness in the aged and the implications of early intervention.

Targeting

Prevention is but one aspect of a larger phenomenon of early intervention to alter the course of a problem. In a sense, any type of treatment represents such an intervention. The fundamental principles of clinical medicine argue that one begins with a diagnosis and then applies an appropriate treatment. Diagnosis is the art of classifying a problem into a set of problems with common etiology as a basis for treatment or at least prediction of the patient's course. It would be unthinkable to apply penicillin indiscriminately in the hopes that some might profit from receiving it. But we sometimes approach this behavior in mounting social programs.

HSR is sorely needed to analyze the relationships among client characteristics, interventions, and benefits. The same combination of epidemiologic, economic, social science, and geriatric skills will be required for these purposes. Eventually clinical trials will be necessary to avoid the biases of self-selection and confounding of treatment effects, but even before then, much can be learned from more deliberate, careful examination of existing programs.

We have already noted the need for a new nomenclature and taxonomy. HSR can provide valuable assistance in shaping this new information system and applying it to populations at risk to yield the most useful classifications possible.

Self-Care

Any projection of the growth of the elderly population raises alarms about the manpower required to provide care of various types. The instinctive response is more self-care and greater use of volunteers, including the elderly themselves. There is great appeal in this approach. Anecdotal data suggest that various forms of peer support offer benefits to both the recipient and the donor. There is a long history of using nonprofessional personnel effectively in both social and medical settings. But the introduction of these nonprofessionals can be disruptive and short-lived.

Careful work is needed to identify how and where systems of self-care and peer support can be established and maintained. What types of clients can they best serve, and with what effect? What kinds of organizational support can sustain such programs?

Value Preferences

Controlled clinical trials and comparisons against standard prognoses will help inform us about the effects of interventions. Such studies do not tell us what effects are desirable. For this information, another line of inquiry is needed into the health outcomes that are most valued by elderly persons. Work on measuring value preferences with regard to health in general is in its early stages of development (Mushkin and Dunlop, 1979). If an older person were to understand fully the risks inherent in each choice of therapy, what would his choice be? How risk-aversive are the elderly? Which risks are the most feared? Models for these kinds of explorations are provided by work in other fields, such as McNeil's studies of the choices of cancer patients for surgery or other therapies (McNeil, Weichselbaum, and Pauker, 1978). Investigations of the choices of the elderly should extend beyond questions of regimens and medical procedures to issues of locus of treatment and the amount of life change the individual is willing to trade for increased life expectancy or for improved functional status.

Value preferences of family members and of taxpayers are also relevant to the kind of care that elderly persons seek or that is financed pubicly. In the context of the geriatric unit, studies of the values of family members could also be undertaken. Here the questions would concern the degree to which independence of an elderly relative is valued above the safety or security of that individual and the family's convenience or peace of mind. It is not always clear that family members are aware of the likely implications of alternative choices when they make their decisions.

Furthermore, elderly persons and their families often make extremely important health-related decisions under enormous personal stress. Research into the correlates of decisions to undertake high-risk surgery, to enter a nursing home, or to move to another city for health reasons would be very useful. The role of family influences and social and economic circumstances in shaping such decisions also merits study (Kane, 1978). Such information could help caregivers create conditions that will minimize the decisions of elderly people and their families to accept LTC under conditions that they later regret.

Longitudinal Studies

A number of the studies refer to the need for measurements of change over time in a defined population sample. Longitudinal studies of the elderly have been a mainstay of gerontologic epidemiology for several decades. Although such studies may offer a rich data base on physiologic, biochemical, and social changes associated with aging, much less is known about the factors that relate various forms of treatment to changes in health status.

TRAINING SITES FOR GERIATRICS

Programs to train geriatricians and geriatrically oriented physicians will require appropriate training sites. The growing numbers of elderly persons assure an adequate patient pool, but the availability of good models of care is much more constrained. As we have already noted, the present and future problems of geriatrics lie in the quality of services provided, not their quantity. The surfeit of physicians should assure a pool of doctors to serve the elderly. The pressing issue is how such care should be organized and provided.

Model programs are needed both to identify the best ways of providing such care and to offer students an environment in which they can experience the opportunities of giving good care to the elderly. A basic goal of geriatraic training programs is to bond themselves to such model programs. But in many instances it may be easier to make them than to find them.

We are highly critical of most long-term care and are quick to believe that closer affiliation with academe cannot but improve the current quality of care. Students at all levels are likely to enter their LTC training with negative attitudes toward the field and the clients. It is therefore critical that they participate in a positive experience. The environment must be one in which they can begin by working at a pace that maximizes their chances of having a beneficial effect. Given the current level of uncertainty about how best to provide LTC, it appears most unwise to lay the double burdens of cost containment and training on the backs of these vanguard long-term care institutions.

The creation of model care programs is a major undertaking requiring substantial and diverse resources. There are compelling reasons to consider renovation over new construction, but working with an established program also presents serious problems. The prototype which comes first to mind is the teaching hospital. This model offers cause for concern. It is not at all clear that a LTC service could withstand the burdens of becoming a teaching service to the extent represented by this design. We have already witnessed the problems created by moving full tilt to establish ambulatory programs as part of a teaching hospital. At best they are expensive and cumbersome. LTC generally lacks the resources and the financing to pay that price.

The question of how to allocate costs and services attributable to trainee experience is likely to be even more complex in the nursing home than the hospital, and it remains an unresoved issue in the latter. Because nursing homes are smaller, less well staffed, and reimbursed at a lower rate, the marginal effects of grafting on a teaching program will be greater than in the hospital setting. Few can absorb the administrative overhead associated with an office of medical education without special provisions. Nor can such an administrative structure be readily justified, even for the training of diverse health professionals. Some form of affiliation or consortium may be appropriate. Given the prevalence of chain operations, some natural linkages may be in place.

However, most of these chains, like the large majority of nursing homes, are operated for profit. The traditional teaching hospital has been a non-profit institution. It is not clear whether proprietary

LTC institutions can or should be used as teaching sites. Two arguments in favor of their use are (1) they are the modal setting for institutional LTC and (2) anecdotal experience indicates the feasibility of cooperative, beneficial linkages between a university and such organizations. Nonetheless, there remains some question about the potential for conflicting goals and philosophy, especially when the presence of a teaching program may threaten operating efficiency, as reflected in profit.

Although it is axiomatic that we cannot be efficient until we are first effective, we all too frequently leap into the breach. We demand proof of efficiency prematurely. Training for LTC will require a long-term investment. As LTC institutions are transformed into teaching sites, we will need to identify means by which the educational activities can be supported without drawing upon the payments for care. In some instances, particularly at the outset, it will be more appropriate to consider additional compensation to the facility to offset disruption costs.

Teaching sites in LTC institutions should not be designed to help the students adapt to the constraints of LTC. Rather they should be viewed as opportunities to reconceptualize roles and approaches to LTC clients. The goal of collaboration between the university and the institution is to develop means of treating LTC clients that are consistent with real world resource constraints. But the best strategy to achieve this goal need not lie in starting with those constraints foremost in one's mind.

We need only recall the state of the community hospital at the turn of this century to appreciate how far we have come through such collaboration. Although we may not seek to replicate the high level of technologic care represented by the contemporary hospital, the extent of progress achieved argues strongly in favor of such a collaborative approach for recognizing the need to provide sufficient resources to make innovation possible.

RECOMMENDATIONS

1. A diversified strategy is required to meet the need for geriatric medical care.
   a. Primary-care physicians in internal medicine and family practice need special training in the care of the elderly. These include appropriate diagnostic strategies, therapeutic regimens, and special management of multiple social, economic, and emotional, as well as physicial problems.
   b. Nonphysician primary care providers (i.e., nurse practitioners and physician assistants) with special preparation in geriatrics need to be trained and federal reimbursement policies need to be altered to allow them to be paid without on-site physician supervision.
   c. A corps of specially trained physicians with advanced skills in geriatrics will be needed as well to manage (or consult on the management of) more complex cases.

   The most appropriate relative proportions of these three types of providers remains a matter of debate, the aggregate deficit, both current and projected, is sufficiently large to urge new training activities. Over 10,000 new geriatric providers are needed in the next decade.

2. Training of providers in geriatrics will require a corps of academic geriatricians. These physicians must be trained, recruited to an academic career, and allowed to prosper in academe.

    a. Geriatric fellowship training programs must be expanded.

    b. Research support for both training of physician researchers and support of their research work is needed.

    c. Because innovative educational techniques are necessary to attract medical students to geriatrics, support for program and product development is required.

3. The gap between knowledge needed to effectively care for elderly patients and our present expertise is large. Although there is a substantial and growing body of basic science research on aging (conducted primarily by nonphysicians), there is not commensurate activity in the areas of clinical research on geriatrics or research on better ways to organize and deliver geriatric services. Physicians need to be attracted to this research for the contributions their training can offer and as a means to assure their continued academic growth.

    a. Stipends to support research fellowship training must be raised to make them compatible with the salaries paid to house officers. Currently, a physician opting to pursue a research fellowship must often suffer a reduction in salary from his stipend as a resident. One exception to this rule are the VA geriatric fellows who are paid a salary that supplies an incentive.

b. Research support grants should be made for longer periods of time than the usual one to two years now awarded. Research funding is tenuous at best. Particularly for the new investigator, the pressure to show results after a brief period may produce several deleterious effects. He/she may pursue more trivial work capable of generating earlier results. Much research effort and time may be spent preparing reports and applications. The novice researcher may grow discouraged at the unavailability of stable support and abandon a promising academic career. On the other hand, lengthening award periods may mean making fewer awards. Decisions about how to allocate research support must balance these conflicting pressures. Perhaps new investigator awards might be made for longer periods as a first step to enable trained physicians to address the more meaningful, but concommitantly more difficult, questions. In the long run, more support for geriatric research will be an essential factor.

c. Another strategy to be considered, especially in the early stages of the evolution of geriatrics as a field, is the funding of a limited number of centers of excellence. This model has been followed in a number of other medical entities to provide support for a core mass to undertake both research and training activities. Such centers would then be expected to supply both personnel and techniques of care to the larger field. Given the small numbers of currently qualified persons available and the broad range of talents and disciplines required, the approach has real appeal. However, such a consolidation strategy echoes the issue of how to allocate scarce research support. Funds directed to support these centers would not be available to those in other academic institutions. Again, the center approach will therefore be of maximal benefit in the early days of faculty training when most of the needed products of training will not yet have been deployed.

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PSYCHOSOCIAL FACTORS IN HEALTH OVER THE LIFE COURSE

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PSYCHOSOCIAL FACTORS IN HEALTH OVER THE LIFE COURSE: A SOCIAL STRESS PERSPECTIVE

I. INTRODUCTION

The study of psychosocial stress and health and the study of aging over the life course have much in common. Most notably, both are inherently interdisciplinary, concerned with the interplay of social, psychological, and biological phenomena in determining human behavior and functioning. The modern fields of research on both stress and aging have tended to move from an initial focus on biological and physiological phenomena to increasing concern with psychological and social phenomena. As social psychologists, we are delighted to see the development of strong research on psychological and social aspects of both stress and aging. But as students of psychosocial factors in health, we see a strong need for understanding the complex relationships between psychosocial and biological or physiological aspects of stress and aging, and are concerned that too often research on psychosocial aspects of stress and aging, at least that done outside the laboratory, tends to be carried out with too little concern for or attention to related biological phenomena; and psychosocial factors are similarly neglected in much biological research on these topics.

Thus, one of the greatest needs in the study of stress and health and of aging is for more truly interdisciplinary research which simultaneously considers social, psychological, and biological factors. A life course perspective can help to foster such integration in research on stress and health and a stress perspective can help to foster such research on aging.

Here is a great, but as yet only partially realized, potential for constructive interchange between, and integration of theory and research in the areas of stress and aging (George, 1980, provides an excellent recent example of the potential of this approach which we draw on below).

This chapter seeks to indicate what we have learned and might learn from applying a paradigm for stress and health research to the study of aging and human development and from taking a life course perspective in the study of psychosocial stress and health. The stress paradigm provides one very useful basis for analyzing and understanding the evolution of health and well-being across the life cycle. Age and life cycle positions in turn have potentially significant associations with, and effects on, the variables and causal relationships that are central to the study of stress and health. However, it is time to move beyond recognizing the *potential* value of a life course perspective on stress or a stress perspective on the life course to specify how the intersection of these two perspectives has or has not, or can and cannot, provide new theoretical, empirical, and practical insights into the evolution of health and disease in adulthood.[1] We begin with a brief overview of the stress paradigm, which, when viewed in a life course perspective, suggests three focal issues for our review.

> A Paradigm for "Stress Research" (from House & Jackman, 1979)
>
> "Stress" has been used to refer to environmental stimuli or situations, individual cognitions or emotions, and physiological responses. Although there neither is nor can be agreement on a single conceptual or operational definition of "stress," we and others (cf. Levine and Scotch, 1970; McGrath, 1970) still feel that "stress research" constitutes a meaningful body of literature grounded in a distinctive metatheoretical paradigm that helps

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[1] We adopt here the view of Birren and Renner (1977:3) that the study of aging focuses on the life cycle of organisms from physical maturity onward. Although the aging process is obviously affected by the process of development up to physical maturity, limitations of time and space require us to focus here on stress and health during adulthood.

"the investigator to ask more meaningful questions and to consider variables he might not have looked at had he used a more limited and conventional perspective" (Mechanic, 1970, p. 106). Various authors (French, Rogers, & Cobb, 1974; Levine & Scotch, 1970, pp. 200–231; McGrath, 1970, pp. 15–17) see five classes of variables as necessary in any comprehensive paradigm of stress research: (1) objective social conditions conducive to stress, (2) individual perceptions of stress, (3) individual responses (physiological, affective, and behavioral) to perceived stress, (4) more enduring outcomes of perceived stress and responses thereto, and (5) individual and situational conditioning variables that specify the relationships among the first four sets of factors. Figure 1 presents a model relating these five classes of variables. The arrows between boxes indicate hypothesized causal relationships, while the arrows coming down from the box labeled "conditioning variables" indicate that social and individual variables condition or specify the nature of these relationships (as explained below).

The paradigm has important implications for the study of stress (or psychosocial factors, more generally) and health. The paradigm emphasizes that particular objective, social, or environmental conditions do not invariably give rise to particular health outcomes, but rather their impact depends on how these conditions are perceived and responded to by human factors. Stress research deals broadly with how individuals react to situations where their usual modes of behavior are insufficient, and consequences of not adapting are serious—generally situations where the demands made severely test persons' existing abilities or where there are substantial obstacles to the fulfillment of strong needs and values (cf. French *et al.*, 1974). But any particular social or environmental condition will be perceived as stressful (i.e., threatening, frightening, overly demanding, etc.) by some persons but not by others, depending on the characteristics of the persons and other aspects of their social situations (the conditioning variables in Figure 1). The perception of stress may lead to somewhat transient behavioral, psychological, or physiological *responses* (e.g., taking an alcoholic drink, feeling anxious or sad, a rise in blood pressure) and ultimately to more enduring health outcomes (e.g., alcoholism, neurosis,

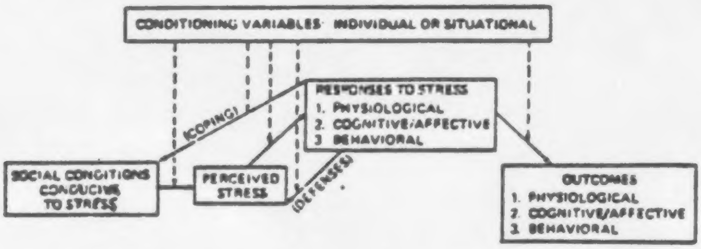

Figure 1. A paradigm of stress research. Solid arrows between boxes indicate presumed causal relationships among variables. Dotted arrows from the box labeled "conditioning variables" intersect solid arrows, indicating an interaction between the conditioning variables and the variables in the box at the beginning of the solid arrow in predicting variables in the box at the head of the solid arrow (From House, J. S Occupational stress and coronary heart disease: A review and theoretical integration. *Journal of Health and Social Behavior*, 1974, *15*, p. 130. Reprinted by permission of the publisher.)

> essential hypertension). However, perceived stress produces a particular response only for certain individuals or in certain situations, whereas the more enduring outcome of a given response depends on how the response affects the precipitating objective conditions and/or perceptions of stress and whether the person is particularly vulnerable (due to prior medical history problems, genetic weaknesses, lack of social support, etc.) to a given outcome.
>
> Consider a concrete example from the area of occupational stress. High levels of work load and responsibility constitute potential stressors, but people with differing abilities, training, and needs will react differently to these potential stressors—some finding them pleasant challenges and others perceiving them as more than they can handle (i.e., stressful). However, even individuals experiencing the same degree of perceived stress will manifest a variety of responses and, hence, also a variety of health outcomes. Faced with excessive work load or responsibility, one person may do nothing; another will strive to meet the challenge by working harder; another may reorganize his work activities or gain new skills, or call on others for assistance, thus reducing the level of work load and responsibility and the degree to which these are perceived as stressful; another may deny or repress the perception of stress. The pattern of responses will be determined by the interaction of the perceived stress and various conditioning variables (e.g., social supports, personality).
>
> If the objective conditions or the capacity of the person for dealing with them can be changed (arrow labeled "coping" in Figure 1), no enduring deleterious health outcomes are likely. If the objective conditions remain the same, efforts to deny or repress perceptions (defenses in Figure 1) may temporarily relieve anxiety, physiological arousal, and some behavioral responses; but since such responses involve perceptual distortions they are likely to lead ultimately to neurotic problems or to bring on further stresses (as the person becomes less in touch with reality). Unsuccessful coping and/or failure to act at all are likely to produce chronically elevated levels of associated behavioral, psychological, and physiological reactions (e.g., drinking, anxiety, blood pressure) and perhaps even death (e.g., overdose, suicide, heart attack). But whether an initially transient response, even if prolonged, produces a chronic or enduring outcome depends on genetic predispositions, other personal characteristics (e.g., sex, poor nutrition, physical conditions), environmental exposures (to microorganisms and toxins), or other conditioning factors that may increase or decrease the likelihood of a given permanent outcome.

An important set of feedback loops—from outcomes to preceding variables in the model is not indicated in Figure 1. These feedback loops are not critical to much stress and health research that focuses on the etiology of disease. However, in a life course perspective, the stress process in continuing and illness is itself a potential stressor. Thus, attention must be paid to such feedback loops, though limitations of time and space preclude our focusing on them here.

A Life Cycle Perspective

This framework is inextricably linked to processes of aging and progress through the life course because age or position in the life course are exogenous determinants of the five classes of variables in Figure 1. That is, changes in age or life course position may affect exposure to social conditions conducive to stress, perceptions of stress, short-term responses to stress, ending outcomes, or conditioning variables. Enduring states of health decline with age. A major unanswered question, however, is why this occurs.

There is clearly an intrinsic aging process which culminates in declines of physical and mental functioning. But the relation of these functional declines to both chronological age and life cycle position are somewhat variable across individuals. This variability is a function of the degree to which individuals possess or are exposed to factors (including stress) which are deleterious to health as opposed to factors which promote or protect health. In the stress paradigm of Figure 1, these factors are encompassed in the two categories— (1) social conditions conducive to stress (or potential stressors) and (2) conditioning variables—which constitute exogenous variables in the stress process. Thus, after briefly considering what we know about the relation of age and/or life cycle status to health, this chapter will focus on how age and life cycle status relate to social conditions conducive to stress, perceptions of stress and to the conditioning variables that may exacerbate or alleviate the impact on health of potentially stressful social conditions or perceptions thereof.

Understanding whether and to what extent potential stressors and conditioning variables vary by age or life cycle status is crucial to answering several questions of substantial popular and practical, as well as scientific, interest:

(1) Do exposure to potential stressors (chronic or acute) and availability of conditioning variables vary by age or life cycle status in ways that produce "crisis" periods for many individuals. How important are age and life cycle status as determinants of stress exposure or conditioning variables compared to other major social or psychological variables? Much has been written about the importance of developmental "crises" in general or specific crises (parenthood, midlife, retirement, etc.), but the empirical evidence for the existence and health impact of such crises is debatable. Our analysis will clarify, though not resolve, these issues.

(2) To what extent do biological or physiological changes associated with aging make people more "vulnerable" to stress, i.e., more likely to develop deleterious health outcomes in response to potential stressors or perceptions of stress. How invariant and irreversible are these changes and what practical and scientific implications do they have for those concerned both with stress and health and with the life course and aging?

(3) Analagously, to what extent do social and psychological conditioning variables change with age in that it makes people more (or less) vulnerable to stress? How invariant or irreversible are these changes?

Do some of these variables also change in ways that can enhance "resistance" to stress? What practical and scientific implications do these changes have for those concerned both with stress and health and with the life course and aging?

II. STRESS AND HEALTH OVER THE LIFE COURSE

Physical and Mental Health Outcomes

Much of the last two decade's research on aging has been directed toward showing that social, psychological and even physical functioning do not invariably decline with age. Continuity between the early and later parts of the life cycle is much greater than is often believed, and the majority of people over age 65 (or even age 70) experience little or no significant decrement in physical, psychological, or social functioning (cf. Maddox, 1979). The view of aging as a steady and progressive deterioration in functioning has now been so discredited that Palmore (1979) has even written of the advantages of growing old.

This "new" view of aging and the aged has had important implications for research and social policy. However, it ought not lead us to lose sight of the fact that increases in physical morbidity and mortality are the strongest and most regular correlates of age and that age is generally the best predictor of most forms of physical morbidity and mortality (cf. Verbrugge, 1980). This phenomenon must, therefore, be a central focus of any analysis of psychosocial factors and health or aging and health. Yet, like sex differences in health, the association of age with health is more widely recognized and "controlled for" than it is analyzed. Epidemiologists, social and otherwise, routinely control for age (and sex) in their analyses of the etiology of health and disease, but rarely do they attempt to explicate or explain why age (or sex) is so regularly related to differences in health. Even analyses of psychosocial stress factors in health among the aged have not usually focused on how and why psychosocial factors do and do not play a role in the deterioration of health with age. This kind of analysis will require much more recognition that age is simply a proxy variable (cf. Maddox, 1979:120-21) for a number of other factors which are both biological and psychosocial in nature, and the age trends in physical health and disease are a function of interrelated biological and psychosocial factors--an issue we return to below.

Variations by age in mental health, other than organic disorders are not as clear, consistent, or regular as changes in physical health. Studies of the prevalence of psychological disorder in general populations have not found a consistent relationship with age, especially during adulthood (Dohrenwend and Dohrenwend, 1969:Table 2). Notably, the Midtown Manhattan Study though confined to an age range of 20-59, found strong evidence of increasing psychological impairment with age in 1954, but a reinterview of many respondents from that study in 1974 showed that on the average impairment did not increase as these people grew older.[2] At very old age (75+) psychological disorders may clearly increase, but prior to that they do not appear to increase or decrease regularly across the life span. Studies of affective states suggest a similar lack of uniform age variation in mental health. For example, the most comprehensive national surveys of quality of life suggest that happiness decreases somewhat with age, but life satisfaction increases over the life cycle (Campbell, et al., 1976). In sum, data on mental health, in contrast to those on physical health, suggest that people adapt rather well psychologically to changes over the life course, a conclusion confirmed by data on exposure to objective stress and perceived stress to which we now turn.

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[2] The 1954 differences appear to represent a cohort effect in which people aged 40-59 in 1954 were more impaired than the people aged 20-39 in 1954 were in in 1954 or 1974 (when they were 40-59). The general problem of distinguishing aging vs. cohort effects is well known, is not easily resolved, and must be borne in mind in all discussions of age differences.

Exposure to Potential Stressors

Most stress research focuses on a single event or situation that is potentially stressful. In some cases—for example, natural disaster—the stressor studied confronts people at all stages of life. More typically, however, the critical event is associated with some transition in the life course. Researchers tend to restrict their studies to either men or women because the sexes experience different stressors and also experience similar stressors in different ways (Lowenthal, et al., 1975).

The key life transitions of young adulthood involve the taking on of life roles. Young adults typically complete their education, enter their jobs or careers, marry, and have their first children (Lowenthal, et al., 1975; Rossi, 1979). During middle age, adults face a number of potentially stressful losses. Some of these are concrete and specific— children leave home, parents become ill or die. Other challenges of middle age are more diffuse but the popularity of books and articles on the "mid-life crisis" (Levinson, 1977-78; Sheehy, 1976; Rubin, 1979) suggests that the phenomenon exists for some people. Older adults contend with loss events such as retirement (Streib & Schneider, 1971; Kalt & Atchley, 1976; Kohn, 1975), failing health of self and spouse (Fenster and Goodrich, 1979), widowhood (Lopata, 1973; Glick, Weiss and Parkes, 1974; Parkes, 1972), and institutionalization (Tobin and Lieberman, 1976; Wax, 1979).

Studies of these transitions have done much to advance our understanding of the life cycle but research into single events or transitions also leaves many gaps in our knowledge of aging, stress and health. First, most of the transitions described are only potentially stressful. Some men miss their mid-life crisis (Nachman, 1979), many women welcome the "empty nest" (Lowenthal and Chiribaga, 1972), and even institutionalization is experienced with relief by some (Smith and Bengston, 1979). The stressfulness of life transitions is conditioned by a host of variables. For example, social support affects adjustment to childbirth (Nuckolls et al., 1972) and to retirement and widowhood (Lowenthal and Haven, 1968). A second limitation is the lack of perspective inherent in the single event approach. More comparative research is needed to determine if some stages of life are more stressful than others. Finally, too great a focus on critical events can lead us to neglect many chronic stresses which, although not associated with life transitions, may be concentrated in certain age groups. Poverty, marital strife, and occupational stress are examples of these chronic stresses.

A second approach to stress research, the summary of recent life events, allows for a more global assessment of exposure to stress over the life course. Changes in life patterns, be they positive (marriage) or negative (job loss), require some adaptation and are, therefore, potentially stressful. Several checklists exist to measure exposure to stressful life events. Generally, the measures include both positive and negative events that are weighted according to the degree of adjustment they are presumed to require and are then added to arrive at a person's total amount of life change (i.e., stress).

These measures of stress have consistently been found to correlate negatively with age (Holmes and Masuda, 1974; Dekker and Webb, 1974; Uhlenmuth, et al., 1974). Several critics, however, are reluctant to accept the negative correlation as proof that young adults lead the most stressful lives.

Rabkin and Struening (1976) suggest that the life events checklists oversample events of young adulthood. George (1980) observes that although older adults experience fewer life events, the events they do experience--widowhood, retirement, institutionalization--involve major role losses. Of course, the weighting of items is intended to account for the magnitude of events, but a single weight applied to an item for every person checking it can be misleading. For instance, a college student changing apartments and an elderly person entering a nursing home could both receive twenty points for a "change of residence" (Holmes and Rahe, 1967). Furthermore, even the same event (e.g., widowhood) may have quite different meanings and effects at different ages or stages of life.

It is clear that a mechanical summing of life events will not allow us to compare people's exposure to stress at different ages. A greater attention to the content of the life events scales will provide firmer grounding for comparative research. Some researchers are already exploring the relative impact of positive vs. negative events (Mueller et al., 1977) and of role gains vs. role losses (Paykel, 1974). Various weightings schemes are compared as well (Rubin et al., 1971).

Further tinkering with the life events instruments will likely provide diminishing returns in our ability to compare people's stress and predict illness. Although change can be stressful, stress should not be equated with change. There is strong evidence that chronic stress of a type not measured in life events scales can adversely affect physical and mental well-being. This has been well documented for occupational stress (House and Jackman, 1976; House, 1974; Caplan et al., 1975; Frankenhaeuser and Gardell, 1976). Pearlin and Radabough (1980) conclude that persistant marital strife has more deleterious effects on mental health than does the event of divorce.

Pearlin's distinction between normative transitions, unscheduled events and role strains is an important theoretical advance in stress research. His approach to measuring stress exposure is more comprehensive than the previously discussed methods in three respects: it allows for comparison of different age groups, it includes both life events and chronic stresses, and it includes all major life roles. Pearlin and Radabough (1980) describe the exposure to stress of men and women in three age categories: under forty, forty to fifty-five, and over fifty-five. We will summarize their findings below.

Normative transitions are life events of an expected, scheduled character. The normative transitions discussed by Pearlin and Radabough concentrate in the under forty age category. Young adults in their study are more likely than older adults to experience job entry, marriage, birth of children, children entering school and their first child becoming a teenager. Adults aged forty to fifty-five most often experience the loss of their spouse through death, their last child becoming a teen, and their first child leaving home. Only two normative transitions, retirement and the last child leaving home, are most common for adults over fifty-five.

Older adults are the least likely to experience non-normative transitions as well. Non-normative transitions are unexpected life events. Only one of these transitions—illness of a spouse—occurs most frequently for adults over fifty-five. Young adults are most likely to change jobs, be promoted on their job, and to divorce or separate from their spouse. Young and middle age adults are both more likely than older adults to be fired or laid off and to be unemployed for health reasons. Surprisingly, illness and death of children are not clearly associated with the age of parents.

Finally, Pearlin and Radabough discuss role strains. These are relatively durable problems, frustrations and conflicts built into the daily roles of people (e.g., poverty or persistant marital conflict). The inclusion of chronic stress in their typology is an important contribution of Pearlin and his associates. This element is often missing in other stress research (with the exception of the occupational stress literature). The prevalence of role strain testifies to its importance. In the Pearlin and Radabough report, people at all ages experience chronic role strains far more frequently than they experience life transitions.

Of the eleven role strains discussed, none is most frequently experienced by the older adults, although one strain, lack of reciprocity in marriage, is encountered by them about as often as by young and middle aged adults. Occupational strains of overload and depersonalizing work relations are most often faced by young adults. Young and middle aged adults experience inadequate job rewards and noxious work environments at similar levels. The low degrees of occupational strain of older adults is probably due to a combination of their being retired and to their greater satisfaction during their last years of employment. Young adults experience the most marital role strain (non-fulfillment of expectations and non-acceptance by spouse) and also the most economic problems. Middle aged adults encounter the greatest parental role strain (failure of their children to respect them, to comport themselves acceptably and to act toward goals).[3]

It is time to sum up what we know about exposure to stress over the life course. It appears that young adults lead the most stressful lives. They experience the most life events, and in three of the four life roles discussed by Pearlin and Radabough, they experience the most role strain. At this time however, we must reserve judgment about exposure levels. Although young adults experience the greatest number of life events we do not know enough about the magnitude or impact of various events to measure and compare their stressfulness. Pearlin and Radabough's role strain data are also equivocal because they are subjective in nature and neglect one important source of chronic stress associated with age and failing health.

We can be certain of two facts, however: (1) as people age they are more likely to experience loss events, and (2) as people age, the total amount of stress they have experienced increases. It is possible that this accumulation of wear and tear is more consequential for health than is the amount of stress exposure at any single point in time.

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[3] One problem with Pearlin's role strain measure should be mentioned. There is no clear distinction between objective stress and a person's perception of stress. Unfortunately this critical theoretical distinction is hard to make operationally. It is not impossible, however, as work on occupational stress demonstrates (House et al., 1979, Frankenhaeuser and Gardell, 1976). The confusion of objective and subjective role strain makes causal inference difficult especially when the role strain measures are related to psychological distress measures from the same survey. It also makes it unclear whether the lack of age differences in role strain reflects a lack of differences in objective exposure to stressors or differential ability to adapt to unequal objective stressors such that, for example, older (or younger) people experience more objective stressors but adapt more effectively to them.

Perception of Stress

Thanks to survey research, we probably know more about the perception of stress through the life cycle than we know about actual exposure to potential stressors. Gurin, Veroff, and Feld (1960) were among the first to systematically explain age differences in the perception of stress. They reported that as people grow older they worry less. More recently, Campbell, Converse and Rodgers (1976) found that older Americans report greater overall satisfaction with life than do young Americans. In the same study, and again in 1978, people under 30 describe their lives as hard rather than easy and tied down rather than free more often than do older respondents. Younger people are also more concerned than older people that they might have a nervous breakdown (Campbell, 1979).

These trends in global perception are generally consistent with the trends in specific life domains. Age is positively correlated with overall job satisfaction and negatively correlated with perceived job stress (Gurin et al., 1960; Campbell et al., 1976; House, 1980). Older workers are, however, more likely than younger workers to agree that they would quit their jobs if they did not need the money.

Perceived stress in marital and family life is more closely tied to the family life cycle (Duxall, 1977) than it is to age per se. Young married adults without children report high satisfaction and low stress. A drop in marital and family satisfaction occurs with birth of children. Both men and women at this stage report more strain than at any other stage of married life, but the increase in perceived stress with the advent of parenthood is greater for women. Methods of young children compared to childless married women the the same age express a greater feeling of being tied down, find life hard rather than easy, are more concerned with financial problems, and may frequently fear they will have a nervous breakdown (Campbell, 1979).

This emphasis on the perceived stressfulness of the first years of parenthood may seem to contradict Pearlin's and Radabough's report of the greatest parental role strain for adults aged 40-55. The apparent conflict, no doubt, results from the criteria of parental role strain, unacceptable comportment, failure to act toward goals, and disrespect for parents. These items seem biased in favor of the "sturm and drang" of adolescence to the neglect of the problems younger children can present (e.g., increased housework, fewer nights out, and general demands on time and energy). Although parents of adolescents experience the greatest interpersonal conflict with their children, it is those with small children who find parenthood the most personally taxing.

Parenthood exacts a toll on the marital relationship, as well. Couples with young children report less overall marital satisfaction, disagree more about spending money, and feel less companionship and mutual understanding in their marriages than do young childless couples. The perception of stress diminishes somewhat when the children enter school and marital satisfaction improves again when children set out on their own (Glenn, 1975; Lowenthal and Chiribaga, 1972; Schram, 1979; Campbell, 1979). Harkins (1978) reports an improvement in adults' psychological well-being following their children's departure. Campbell finds this, as well, and comments, "It is remarkable that this stage of life, often referred to as the "empty nest", should have such lugubrious reputation when it is in fact for most people the most positive period in their married life."

We have, thus far, presented a rather benign view of aging and perceived stress. In one important domain, however, age is associated with an increase in worries and a precipitous decline in satisfaction. This domain is, of course, physical health (Gurin et al., 1960; Campbell et al., 1976; Campbell, 1979).

Like the role strain findings of Pearlin and Radabough the research on life satisfaction confounds objective exposure to stressors with the perception of stress. For example, the increase in work satisfaction with age is subject to various interpretations. It is possible that, with age, people either quit or are promoted out of odious jobs. It is also possible that objective work conditions do not appreciably improve with age but that workers perceive their jobs as less stressful. This could come about through a lowering of aspirations or by the development of personal resources which enable older workers to view with equanimity situations that would distress younger workers.

This problem of interpretation can only be resolved by comparing the perception of equivalent stressors over the life course. What little evidence exists is provacative. Older adults rate the degree of disruption imposed by various life events lower than do younger adults (Horowitz et al., 1974; Masruda and Holmes, 1978). Of course, this weighting of life events is only hypothetical. What of instances where adults of different ages actually face a similar crisis? In three studies of the impact of floods and tornadoes, older adults compared to younger adults reported less stress and physical anxiety and also were less likely to believe they would never recover from the disaster (Bell, 1978; Huerta and Horton, 1978; and Kilijanek and Drabek, 1979). At least one stressful life event, unemployment due to plant closing, creates greater perceived stress for older employees ( ). This may be the exception that proves the rule, though, for the older workers veridically anticipated they would have a harder time than young workers finding new jobs. This illustrates the importance of understanding the subjective meaning attached to life events.

In every important life domain except health, age is positively related to satisfaction and negatively related to perceived stress. Social psychologists have tended to give a surprisingly gloomy interpretation to this seemingly halcyon fact of aging. Gurin, Veroff and Feld (1960) observed that while older adults worry less they also report less happiness. They concluded that older Americans were passive and resigned to their fate. Campbell and his associates also found a combination of high satisfaction and low happiness with advancing age (Campbell et al., 1976; Campbell, 1979). They hypothesized diminished levels of aspiration as the main cause of the relationship.

A more positive explanation of the trends emphasizes personal control and maturity. To the extent that adults can control their lives age should be associated with declines in objective stress. Older people have quit jobs they found unrewarding, ended unhappy marriages, and moved to more pleasant homes and neighborhoods.

In addition to dropping and changing roles, older adults have adjusted to roles in ways that help them avoid objective stress. Through experience they have learned to get along better with their spouses and coworkers. Two facts support this interpretation. First, age is positively related to perceived locus of control (Campbell et al., 1976). Second, in the one domain of life where perceived stress increases with age people have little ultimate control. Physical deterioration is inexorably linked with advancing years.

Objective conditions do not entirely account for the decline in perceived stress over the life cycle. The relative sangfroid of older disaster victims testifies to the fact that adults of different ages perceive objectively identical situations differently. Perhaps the resiliance of older adults comes from long experience with a variety of stressful life situations. If so, their hard-earned equinamity deserves a less perjorative label than resignation--perhaps maturity or perspective.

Exposure to Stress: Issues of Patterning and Cumulation

Variations in exposure to potential stressors and even perceived stress appear to be only weakly related to chronological age or even life cycle stage, and much more strongly related to social variables (e.g., race, sex, income) which operate throughout the life cycle. A life course perspective, however, focuses attention on the patterning of exposure to stressors with respect to time. That is, although the level of exposure to stressors may not be substantially related to, or determined by, age or life cycle position, the way events cluster, order themselves, or relate to the statistical or normative expectations for their occurrence may be consequential for understanding their impact on health. In this sense, the impact of an event like widowhood (or even a relatively chronic state such as low income or heavy childrearing responsibilities, may vary substantially depending on whether it occurs in close proximity to other events (e.g., job loss), before or after other critical events (e.g., children leaving home), or at an expected (late life) vs. unexpected time (early or middle adulthood). These ideas have been frequently noted, but systematic empirical evidence regarding them is scarce (cf. Neugarten, 1977[7]; Pearlin and Radabough, 1980).

The effects of cumulative exposure to stress over the life course also deserve further attention. Psychosocial stress is one source of "wear and tear" which constitutes one major explanation of the deterioration of organisms with age (Birren and Renner, 1977:9; Eisdorfer and Wilkie, 1977). At present, however, we lack the kind of careful longitudinal research that might show that persons with greater cumulative stress over the life cycle "age" more rapidly or are more susceptible to disease.

The issues of patterning and cumulation are captured by the notion of conditioning effects in the stress framework. That is, the effect of a given type or level of stress at one point in time may be conditional on the level or types of stress previously experienced by the person. It is in the consideration of conditioning variables in a life course perspective that see the greatest potential for mutual advances in the study of stress and health and of aging and human development. Thus, let us consider the way in which three major classes of conditioning variables--biological, psychological, and social--vary with age and the life course and hence alter the impact of stress on health.

Psychological Factors

The attempt to detect and explain age-related changes in psychological functioning or behavior has a long history. Overall, the evidence suggests consistent declines with age in some sensorimotor variables, much of it due to the effects of physiological aging, but little or no consistent age-related trends, at least prior to rather advanced age in those variables most relevant to the way people perceive and respond to psychosocial stress in real-life settings. In the words of Birren and Renner (1977:29): "One of the most established phenomena of aging is the tendency toward slowness of perceptual, motor, and cognitive processes." As people age, they become slower and more error-prone (especially if forced to react quickly) in dealing with behavioral and cognitive tasks and problems (Rabbit, 1977; Welford, 1977). Much of this decline in functioning is due to physiological deterioration in muscular abilities and in the acuity of major sense organs, most notably eyes, ears and skin (Fozard, et al., 1977; Corso, 1977; and Kenshalo, 1977).

There is also some evidence that these declines reflect deterioration in central nervous system functioning as well, perhaps in response to decreased cerebrovascular blood flow (cf. Eisdorfer and Wilkie, 1977:267-70). Longer-term memory functions decline with age (Craik, 1977), as do general intellectual functions, though "decline with age for many functions may not be seen before ages 50 or 60, and even then the decline may be small"(Botwinick, 1977:603). Again changes are most evident in studies involving speeded tests or tasks.

Although perceptual and motoric declines clearly may sometimes inhibit the ability of persons to adapt to psychosocial stress, they are not crucial in most situations. Even declines in speed of intellectual, cognitive, and problem-solving activities, as determined largely from laboratory experiments or standardized tests may not be so critical in adapting to real-life situations where quality of response is much more important than speed or quantity. Thus, more relevant for our purposes are study of "personality" dimensions, including coping styles or dispositions, which may influence people's perceptions of objective stressors or their responses to stress. Here we find little evidence of consistent and consequential age differences.

Reviewing research on age-related changes in many individual dimensions of personality (e.g., egocentrism, locus of control, self-esteem, etc.), Neugarten (1977:636) concludes: "In each area, the findings are notably inconsistent from one study to the next, with some but not other investigators reporting age differences," (with one major exception—introversion increases over the last half of the life cycle). She also reports that "studies of personality organization have been no more consistent than studies of individual personality dimensions and no more enlightening with regard to the direction of change over time" (Neugarten, 1977:638).

The last few years have seen increased study of the way individuals cope with real life situations, most notably by Pearlin and Schooler (1978) and Lazarus and his colleagues (e.g., Folkman and Lazarus, 1980). Although this type of research is in its infancy, it does not appear likely to yield evidence of striking age-related changes in the direction of lesser or greater ability to adapt to stress. Pearlin and Schooler studied the relation of over twenty different psychological resources and styles of coping to age and to a large, representative sample of persons living in the Chicago urbanized area. With respect to age differences in the efficacy of coping, they conclude:

> "The imbalance that exists between the sexes in the distribution of efficacious coping is completely absent with regard to age. Thus, the younger are more likely than the older to be self-denigrating, but they are also more apt than the older to entertain a sense of mastery. In coping with marital problems, the older are more disposed to self-reliance (less often seeking advice) and more likely also to engage in a controlled reflection of marital problems, both of which help to limit stress; but the older, too, more often practice selective ignoring, which is counter-productive in the marital and parental areas. As parents, breadwinners,

> and job-holders, the young and old are each likely to employ mechanisms that support emotional well-being. Unlike the sharp differences observed between men and women, then, there seems to be a balance in the coping efficacy of younger and older people, each being about equally well-equipped with effective elements. These results certainly do not support views of aging as a process in which people inexorably become increasingly vulnerable, unable to cope effectively with life-strains. Although there are substantial relationships between age and coping, neither the younger nor the older appear to have any overall advantage in coping effectiveness. (Pearlin and Schooler, 1978:15-16).

Folkman and Lazarus used a quite different approach, measuring actual coping behaviors in response to stresses in a small community sample of 100 men and women, aged 45-64, who were interviewed at about monthly intervals for almost a year. Considering whether coping efforts focused on the problem or the emotions aroused by the problem, they found "no relationship between age and coping" (Folkman and Lazarus, 1980:233). They go on to suggest that since coping responses are related to types of stresses experienced (as Pearlin and Schooler found), studies of a broader age range one might find changes in the frequency of various coping responses with age as the stresses experienced shift (e.g., from work-related problems in the middle years to health related problems in older age). They rightly emphasize, however, that such changes would not really be a function of personality development.

In the areas most central to our concern with stress and health, the quantity and quality of evidence is still too scanty to draw firm conclusions. As indicated in the above discussion of perceptions of stress, some believe that as people age they adapt their aspirations and expectations to the realities of their life situation, thus reducing some perceived stresses (e.g., work, marital, and life dissatisfaction). Others, however, have argued that observed increases in satisfaction with age, which are the basic data to be explained, reflect improvements in objective life circumstances (an argument consistent with other evidence that objective stressors are higher at younger ages). More explicit tests of the both explanations of changes in satisfaction levels are needed.

These tests also ought to consider more explicitly the possibility of cohort effects, as should research on coping. Although Pearlin and Schooler find no net advantage of the young or the old in coping with stress, they do find the young more likely to engage in some practices, the old in others. It is important to know which of these differences are likely to be due to aging vs. cohort effects. It may be, for example, that aging produces on the average, some greater degree of maturity and ability to adapt or tolerate stress, but that these effects are masked in cross-sectional studies by counter countervailing cohort effects.[4] Overall, however, extant research on psychological change over the adult life cycle yields relatively little evidence of consistent age-related change in variables likely to affect the perception of or responses to psychosocial stress.

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[4] More concretely, Pearlin and Schooler (1978) also show that education is associated with more adaptive modes of coping. Education is greater among younger age cohorts due to expansion of educational opportunities during this century. Thus, a truer test of aging effects must control for education. Net of education age may be more consistently related to adaptive coping. Cohort differences have also been observed in willingness to seek help for personal problems, with more recent cohorts more willing to seek such help, though the consequences of such help for the alleviation of stress are less certain (Kulka and Colton, ; Pearlin and Lieberman,). If help helps, some of the advantageous coping styles of the young found in current cross-sectional studies may reflect such cohort effects, while the advantageous coping styles of the elderly may be due more to aging than might first appear to be the case in a study like Pearlin and Schooler's.

Social Conditioning Factors

Of the many potential social conditioning factors in the stress paradigm, social integration and support receive the most research attention from a life course perspective. Previous research suggests that social relationships can reduce stress, improve health, and buffer the impact of stress on health (Back and Bogdonoff, 1967; Lowenthal and Haven, 1968; Cassel, 1970; Nuckolls et al., 1972; Kaplan et al., 1977, Berkman and Syme, 1979). Two important questions for aging research are: (1) How is social support distributed through the life cycle? and (2) Do the effects of social support vary at different stages of the life cycle?

Aging after middle adulthood is frequently viewed as a series of losses of social roles and relationships (Cummings, 1961). As people grow older, their children grow up and leave home, they retire, and contact with former coworkers decreases, parents, friends, and spouses die. Social support has been demonstrated to protect people from the deleterious health consequences associated with these losses. Raphael (1977) describes an effective application of social support theory in the form of counseling provided to widows determined to be at high risk of physical and mental illness. Lowenthal and Haven (1968) concluded that intimate social relationships buffered against declines in morale and health following age-related social losses. Elderly people low in social support, that is, the single, childless, divorced and widowed, are more likely to be institutionalized than are these high in social support (Palmore, 1976; Treas, 1977; Shanas, 1979).

Age is associated with social losses and social support conditions the stress-disease relationship, but these two facts don't explain as much about aging and health as one might imagine or hope. Not all age-related social losses mean a loss of social support. Lowenthal et al., (1975) suggest that as people age they may relinquish relationships that weren't really emotionally important to them. We need to know more about how substitution of relationships operates with age. Many widowers remarry (Cleveland and Gianturco, 1976) and widowed women, although they are far less likely than widowers to remarry, may also find and maintain supportive relationships. For example, Lopata (1975) describes "couple companionate relationships" between wives and widows. Some have even gone so far as to suggest polygamy as a viable option for the elderly given the demographic distribution of the sexes (Berezin, 1969). Such measures might create more problems than they solve and, at any rate, are probably unnecessary given women's ability to form and maintain intimate non-marital relationships.

Lowenthal and Haven maintain that a single intimate relationship is the critical factor in the morale of the elderly and few people at any age are completely bereft (Ingersoll and Depner, 1980). Shanas (1979) discusses the myth of the socially isolated aged. Ninety-five percent of all persons over sixty-five are community residents, and even among persons over eighty only one in eight is institutionalized. Furthermore, according to her data, half of all adults over sixty-five and living in the community have an adult child living within ten minutes of them.

This is not to say that there are not a considerable number of lonely old people who are in poor health. Ethnographic studies of nursing homes and of single occupancy rooming hotels describe the very real predicament of such people (Wax, 1979); Stephens, 1976). For many of them however, their plight in old age is the culmination of a life of marginality (Pilisik and Minkler, 1980). Except at very advanced ages, the elderly are not generally isolated.

Troll (1980) notes approvingly the shift in emphasis in research on the life course and social networks from atheoretical, pragmatic description to an analysis of the complex processes involved. Since age-related social isolation is rare, an analysis of the effects of various relationships over the life course may be more important than description of the distribution of relationships. As with exposure to stress, the timing and patterning of social support may explain more from a life course perspective than do exposure levels at various ages. We need more research on people's past histories in relation to their present relationships and adaptation. For instance, Clark and Anderson (1967) conclude that people who have always lived alone fare better than those whose close ties are severed.

From a stress and health standpoint, an individual's position in society may be more critical than the person's posiition in social networks. In their study of adult development, Lowenthal and her associates consistently found greater variation between men and women than between people at different life stages. Considerable attention is devoted to how social factors such as sex, class, race and status inconsistency are related to people's exposure and vulnerability to stress (Dohrenwend, 1975; Dohrenwend and Dohrenwend, 1976, 1977; Gove and Tudor, 1977; Pearlin and Schooler, 1978; Kessler, 1979a, 1979b). Some of these factors are known to interact with age in relation to other variables in the stress paradigm.

The following are some examples of such relationships:

1. Blacks in the United States show a greater rise in the incidence of hypertension with age than do whites (U.S. Public Health Service, 1970).

2. Blacks have higher rates of chronic disease and higher mortality than whites from birth to age 75. After age 75 white mortality is higher (Manton et al., 1979).

3. Morale in later life is more strongly correlated with marital satisfaction for women than it is for men while health is more strongly related to morale in later life among men than it is among women (Lee, 1980).

4. Suicide increases steadily with age for white males in the United States with a slight drop after age 85. For white women in the United States suicide is curvilinearly related to age with a peak in the forty to forty-four age range. Among black Americans, suicide is not clearly related to age (Pfeiffer, 1977).

5. The status inconsistency of high occupation and low education is associated with psychological strain for men over forty-five but not for younger men (House and Harkins, 1975).

At present these relationships are not well understood. A life course perspective might help to elucidate the causal processes behind these statistical interactions.

Biological Conditioning Factors

The strongest and most consistent correlates of age are the inexorable processes of biological aging and increased morbidity and mortality. Much of the recent study of aging and human development has attempted to counteract a decrement model of aging in the social, psychological and even biological spheres. To a considerable degree, commonly held beliefs about the severe and steady deterioration of social life and psychological function with age have been shown to be exaggerated. In many ways biological aging proceeds less rapidly and invariantly than is commonly supposed. Nevertheless, decline with age in biological functioning and the ability to avoid or resist noxious environmental agents remains the most certain element of the aging process (Birren and Remer, 1977; Shock, 1977; Finch and Hayflick, 1977). Although causes of these biological changes are not currently well understood, they are still of great importance to understanding the impact of psychosocial factors, especially stress on health in a life course perspective.

Psychosocial stress is one potential cause of, or contributor to biological aging (cf. Eisdorfer and Wilkie, 1977). That is, stress can produce many of the biological and physiological responses characteristic of biological aging, e.g., impairment of the immune system, increases in blood pressure, etc. Accumulations of such "wear and tear" over time is one hypothesized cause of biological and physiological deterioration with age.

More importantly for our present purposes, regardless of the role of stress in producing it, biological aging is likely to make people more susceptible, developing many infections or chronic diseases in response to stress. This interplay between environmental stress and biological aging has been a central concern of experimental biologists. Thus, Handler (1960) defined aging as "the deterioration of a mature organism resulting from time-dependent, essentially irreversible changes intrinsic to all members of a species, such that, with the passage of time, they become increasingly unable to cope with the stresses of the enviornment, thereby increasing the probability of death." Handler's definition is really a hypothesis that biological aging processes are potentially strong conditioners of the impact of stress (psychosocial or otherwise) on health. The same hypothesis emerges from literature on social stress and health which emphasizes that stress has broad and relatively nonspecific physiological effects on the body, thus predisposing people to a wide range of disease (e.g., Cassel, 1976). The specific disease developed by any individual depends not on the nature or level of the stress experienced, but rather on other factors (often biological, physical, or chemical in nature) which make a person liable to a particular disease at a particular time.

Although the potential interplay between psychosocial and biological factors in the generation of health and disease has been addressed theoretically and in some experimental research (e.g., laboratory studies of the role of stress in accelerating processes of corcinogenesis, cf., Riley, 1975; Solomon et al., 1974), social epidemiological research has not explicitly considered the role of age, or biological changes associated therewith, in conditioning the impact of psychosocial factors on health and disease. Age and related biological variables are often treated as control or confounding variables in analyses of the effects of psychosocial variables on health. But seldom do these analyses examine the joint, conditioning (i.e., statistical interaction) effects of "biological aging" and psychosocial stress in producing disease. Such analyses seem to us a priority area for future research on psychosocial factors in health within a life course perspective.

In their crudest form such analyses will consider whether age and psychosocial stress combine interactively as well as additively in predicting health and disease. These analyses would be analagous to pervious work considering how sex, race, socioeconomic status and marital status combine additively and interactively in predicting mental health (cf. Kessler, 1979a and b; Pearlin and Johnson, 1977). The analyses would test not only whether effects of age and stress on health are correlated or confounded with each other, but more importantly whether the impact of stress on health varies by age (or conversely whether the impact of age on health varies by levels of stress to which people are exposed).

At present, there is almost no research which explicitly tests these issues and hypotheses, and the nature of our expectations would vary depending upon the particular stress and health variables in question. A few suggestive findings can be noted, however. In earlier research the first author (House, 1972) observed a consistent tendency for occupational stress to be more strongly associated with heart disease risk factors in middle-aged and older men (≥42) than in younger men, and speculated that this result may reflect an increasing cardiovascular sensitivity to effects of psychosocial stress with age. Consistent with this notion is the fact that rates of cardiovascular disease increase with age, and that the best established psychosocial risk factor of heart disease—the Type A behavior pattern—is somewhat more predictive of coronary disease in men 50-59 years of age than in men 40-49 (Roseman et al., 1976). This difference is small and undoubtedly statistically non-significant, but one wonders whether the effects of Type A may not increase further for men in their sixties. Findings reported below on the relative impact of Type A on persons with and without coronary disease are consistent with this possibility, although data from the Framingham heart study do not show a clear age gradient for the impact of the "Framingham Type A" variable or

Better than using age in such analyses is to obtain direct assessments of major age-related biological changes that may predispose people to major infections or chronic diseases. Decrements in the functioning of the cardiovascular and immune systems seem especially important here, since these systems play a major role in the development of the major sources of morbidity and mortality in the middle and later years (cf. Kohn, 1977; Makinoden, 1977). Although research clearly indicates that psychosocial factors can have deleterious effects on the cardiovascular and immune systems (cf. Jenkins, 1971, 1976; Fox, 1978), there is again a lack of attention to the joint or interactive effects on morbidity or mortality of psychosocial stress in conjunction with indicators of cardiovascular or immune functioning. Suggestive evidence again comes from research on the Type A behavior pattern, which has been found to be much more predictive of subsequent coronary disease in persons with a prior history of such disease (and hence established biological susceptibility) than in persons free of disease ( ). It is plausible that Type A or other psychosocial factors might also be more predictive of disease among persons with markedly high levels of CHD risk factors as opposed to those without elevated risk factors.

incidence of CHD (Haynes et al., 1979). However, there were no subjects in this study under age 45 and the numbers over 65 were quite small.[5]

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[5] It is worth noting that the impact of stress on health or disease should not increase with age for all forms of stress or all forms of health. In the case of mental health, people's adaptive capacities probably increase with age rather than declining, at least until people reach a relatively old age. Second, some stresses may become less consequential with age, at least up to relatively old age. For example, Berkman and Syme (1979) find the impact of lack of social connectedness (esp. lack of a spouse or close friend and relatives) on mortality to be greatest for their youngest (age 30-39) respondents. This may reflect a great normative expectation and acceptance of the loss of spouses, friends, and relatives in later life and/or a greater ability to cope with them.

In sum, a life course perspective helps to pinpoint the importance of biological processes and variables as potential conditioners of the impact of psychosocial stress on health. It is in some ways, a wonder that psychosocial variables have been shown affect physical morbidity and mortality when almost no effort has been made to examine the effects of stress separately among those who are biologically most susceptible to its deleterious effects on health. Thus, attention to processes of biological aging should sharpen our ability to document the impact of psychosocial stress on health. Conversely, a stress perspective suggests that the nature and implications for health and well-being of developmental biological processes depend greatly on the environmental health hazards to which individuals are exposed, including psychosocial stress. In both the study of stress and the study of aging, there is a critical need to bring together psychosocial and biological variables in the same research designs, in field studies as well as in the laboratory. At present, psychosocial research attends too little to biological phenomena, and biological research attends too little to psychosocial variables.

III. SUMMARY AND CONCLUSION

We see this chapter as having two complementary goals: (1) to evaluate the role that psychological factors, here conceptualized in a stress framework, play in understanding changes in health over the adult life course, and (2) to consider how a life course perspective can contribute to understanding the impact of psychosocial factors and stresses on health. We have found a paradigm for stress research (Figure 1) useful for reviewing the relation between psychosocial factors, health and aging. Our review leads us to a number of conclusions about the state of present knowledge, directions for future research, and potential social applications.

First, much popular and scientific literature has focused on the idea that passage through the life course entails a number of psychosocial stress crisis periods, with old age perhaps the most serious of all, which individually and collectively have adverse effects on physical and mental health (e.g., Sheehy, ; Levinson, ; McMaster, ; Holmes and Rahe,). This idea flows naturally out of the confluence of research indicating that life change can adversely affect health (cf. Dohrenwend and Dohrenwend, 1974) and views of the life course as involving a sequential series of significant changes in social roles (e.g., marriage, parenthood, job changes, the "empty nest", retirement, widowhood, etc.). Although there is some evidence that major life changes, especially of a negative variety, can adversely affect health, on the average these effects are not great. Much more impressive is the individual variability in responses to change as a function of other biological, psychological, or social factors. Further, there is little age-related variation in the total level of life change experienced by people, and certainly no clear increase in exposure to such changes as people age (if anything, young adults experience the most change). Thus, although life change has been a hot topic in both stress and aging research, its potential contribution to understanding stress and health over the life course has been, we feel, overrated.

Equally or more consequential for health are the more enduring stresses and strains (financial deprivation, lack of social integration, occupational and familial stress) which people may be exposed to at all ages. Again, however, we find little evidence that the average level of exposure to these stresses varies greatly over the life course. Measures of perceived stresses, in fact, also indicate, if anything, that younger people may experience somewhat more of these types of stresses as well, with the level of stress declining with age, at until people reach quite advanced ages (75+).

Thus, although exposure to stress, measured either objectively or subjectively, does not increase markedly over the life cycle, physical health clearly deteriorates with age. This deterioration in health is itself a significant source of stress as people grow older, but at this point it cannot be attributed to any significant extent to increasing exposures to psychosocial stress over the life course. Rather, it appears that explanations for the decline in health with age must be sought in the increasing vulnerability of people with age to various threats to health, psychosocial as well as biological or physical-chemical. In the stress paradigm this means that our focus should shift from objective conditions conducive to stress or perceptions of stress to psychological, social, or biological factors which condition the impact of stresses on health.

One aspect of such a focus would be increased attention to how the patterning and/or cumulation of stresses over the life course conditions their impact on health. For example, how does the impact of widowhood vary depending on its timing relative to individual and normative expectations and to the presence or past occurrence of other life changes and stresses. If effects of stress cumulate, the effects of a given stress on health should be greater for people who have experienced more earlier stresses or changes. If patterning (or normative expectations) make a difference than the effects of a given stress on health will vary depending on its time of occurrence relative to chronological age or other life course events. Tests of such hypotheses require increased collection and analysis of longitudinal data.[6] Such longitudinal data will not only provide needed information on cumulation and patterning, they will also fill a need for such data in the study of stress and health (cf. Eisdorfer and Wilkie, 1977; House and Jackman, 1979).

More generally, however, we are proposing that analyses of psychosocial factors, aging and health shift from a focus on the relation between age or life course position and levels of objective or perceived stresses to a focus on the role of age and life course position as conditioning variables. In their crudest form these analyses will follow the adapted stress paradigm of Figure 2a. That is, we will consider how age or life course conditions the relationships between other variables in the stress paradigm. We expect that the conditioning effects of age here should be significant and pervasive, though empirical evidence is presently scant.[7]

Age or even life cycle position variables (e.g., "empty nest", retirement) are however, only proxy variables for the psychological, social or biological factors which we think explain any observed conditioning effects of age.

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[6] Some of this data may be obtainable retrospectively, for example, histories of major life events. To the extent, however, that we need assessments of health or perceived stresses as well, the design must be prospective.

[7] Even if the results of such analyses are negative, they would be important in further specifying how study of psychosocial factors can and cannot contribute to the understanding of age-related changes in health.

Thus, there is a need for analyses which elaborate the paradigm of Fig. 2a as indicated in Fig. 2b. This will entail two kinds of work: (a) delineation of the relation of age and life course position to psychological, social and biological factors known (or believed) to condition the relation of psychosocial stress to health and (b) determination of the extent to which those variables (and their conditioning effects) can account for age differences in health.[8]

We have reviewed what is known about the relation of age or life course position to psychological, social, or biological variables which do or may condition the impact of stress on health. Our review suggests a point that changes in psychological variables that are most likely to condition stress-health relationships are not pronounced with age over the bulk of the life course, though there may be substantial changes at very late stages, probably in response to psychological changes. If anything, we would hypothesize that careful research will show that over most of the life course there is a small but steady increase in psychological variables which facilitate adaptation to stress—what some might term growth in psychological maturity. Thus, psychological conditioning variables seem unlikely candidates for explaining the deterioration of health with age.

Social factors are somewhat more promising in this regard.

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[8] There are two possibilities here. First, a conditioning variable similarly conditions relationships at all ages, but the prevalence of the variable increases with age. Alternatively the conditioning effect of the variable may vary by age, becoming, for example, less protective of health with age. Little is known about this latter issue, which involves analyses of second-order statistical interactions (between age, a conditioning variable and a stress variable in predicting health).

The simple distribution of social relationships over the life course does not significantly account for age differences in health. Therefore, analysis of the timing and patterning of social support and of the effects of various social relationships through the life course are of higher priority in future research than is the description of levels of support at various ages.

Social status factors such as sex, race, and socioeconomic status influence the stress paradigm in two important ways. First they are major factors in the exposure to stress. Second, they largely determine people's resources for coping with stress. We know that mental and physical illness are likely to occur with a confluence of high exposure to stress, low levels of coping resources, and biological susceptibility. Socially disadvantaged people are thus likely to age "more rapidly" or with greater physical and mental deterioration. We need to know more, however, about how social status factors influence the perception of stress and specific responses to perceived stress through the life course because a simple deprivation model does not account for all the empirical findings especially the observed sex differences in aging.

Finally, there is clear evidence that biological aging does make people more susceptible to various forms of disease and we hypothesize, therefore, that effects of psychosocial factors on health should be much greater among those with biological vulnerabilities—a hypothesis which is consistant with research and theory on both stress and aging but which has received scant empirical attention. Among specific biological functions, changes in the immune and cardiovascular systems seem most promising and important. Thus, a major frontier for research on aging, stress, and health is to examine the interplay of psychosocial and biological factors in producing declines in health with age.

Our review suggests that the effects of stress on health are real but modest throughout the life cycle, and are likely to be importantly conditioned by people's biological status (disease itself is an increasingly significant stress with age--an important area beyond the scope of this chapter). Paradoxically, however, social and psychological factors should perhaps be equally or more important than biomedical variables in efforts to improve health over the life course. Much of the effect of age and related biological factors on health, are due to factors beyond control or intervention at this point (i.e., changes due to genetic or other intrinsic aging processes that we cannot yet modify by biological interventions). Thus reducing levels of stress or providing social and psychological resources for dealing with them constitute an important means for promoting health. However, we still need to understand whether people with certain biomedical characteristics or conditions benefit more from such interventions than others. Thus, we see again the need for both research and practice in the study of aging, stress and health to bring together the three elements--psychological, social and biological—which are part of any comprehensive life course perspective.

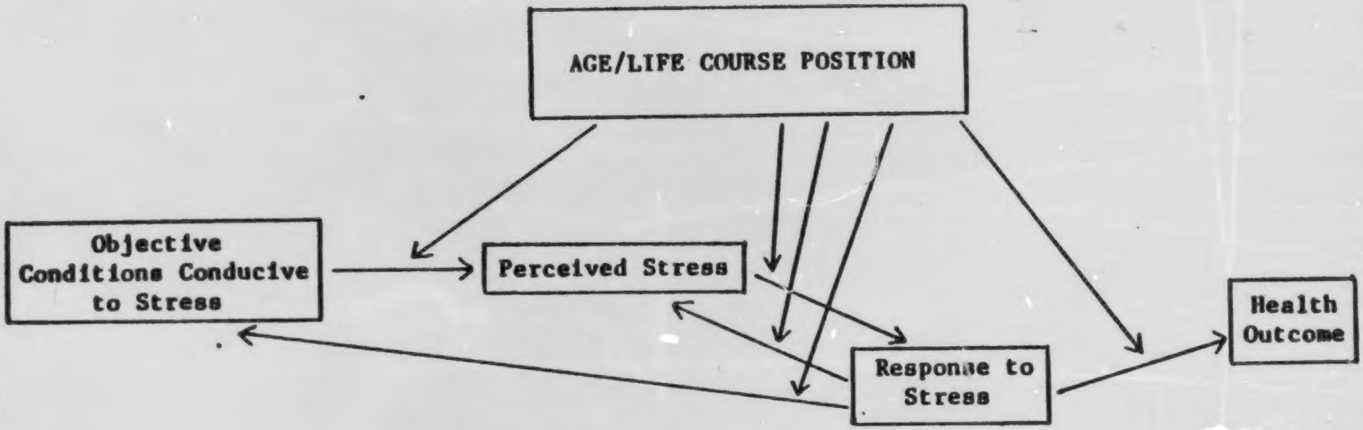
AGE/LIFE COURSE POSITION
Objective Conditions Conducive to Stress
Perceived Stress
Response to Stress
Health Outcome

Figure 2a

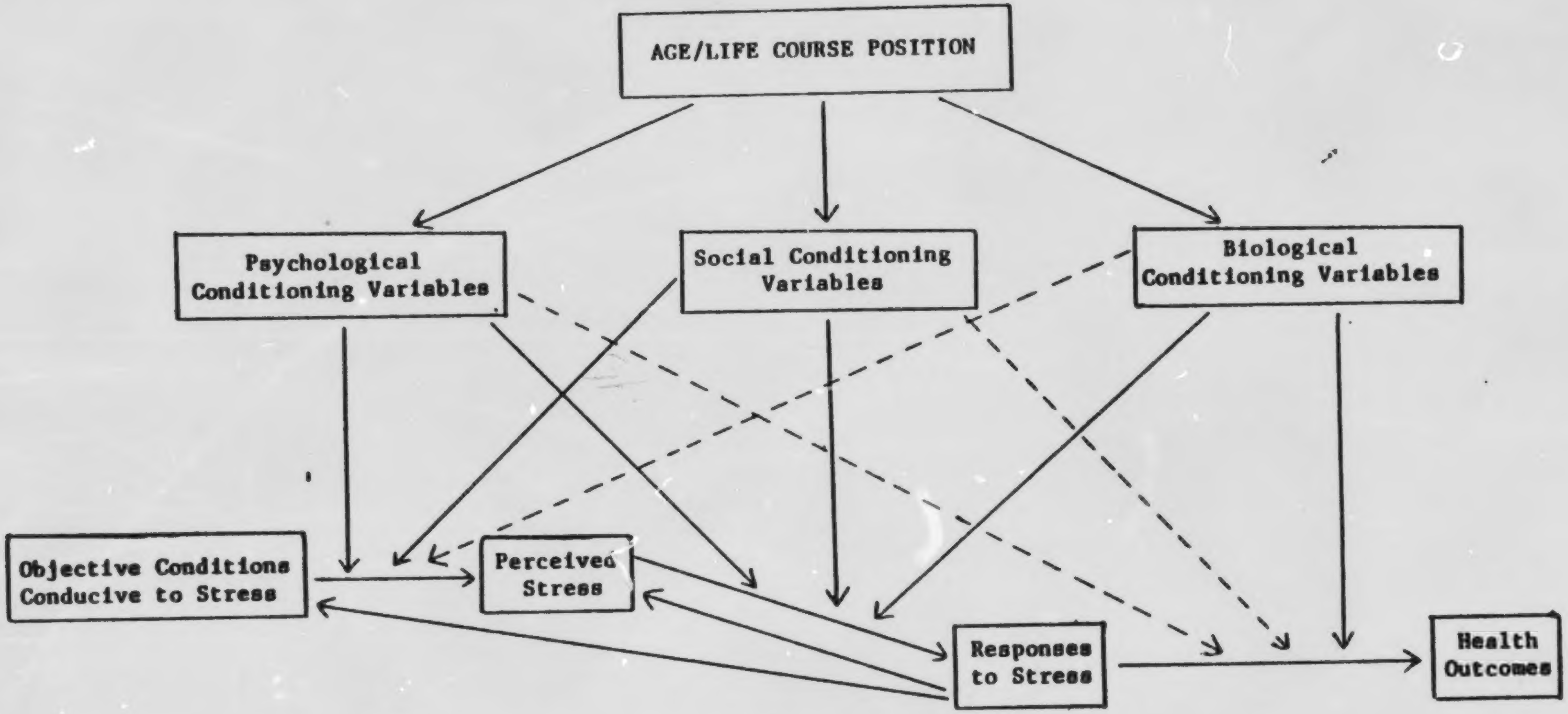
AGE/LIFE COURSE POSITION
Psychological Conditioning Variables
Social Conditioning Variables
Biological Conditioning Variables
Objective Conditions Conducive to Stress
Perceived Stress
Responses to Stress
Health Outcomes

Figure 2b

RESEARCH FRONTIERS IN AGING AND CANCER*

INTERNATIONAL SYMPOSIUM FOR THE 1980's

(Concluding Session: Hearings Before
the House of Representatives Select
Committee on Aging, Sept. 26, 1980)
WASHINGTON, D.C.

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*Summary Statement Prepared for Dr. Ringler's presentation to the National Advisory Council on Aging Meeting - January 29, 1981

RESEARCH FRONTIERS IN AGING AND CANCER*

INTERNATIONAL SYMPOSIUM for the 1980s

Concluding Session: Hearings before the House of Representatives Select Committee on Aging, September 26, 1980, Washington, D.C.

Participants Present

House Select Committee Members
Claude Pepper, Chairman
Marlo Biaggi
Don Bonker
Robert F. Drinan
Daniel Lungren

Symposium Planning Committee
Robert N. Butler, Director, National Institute on Aging
Vincent T. DeVita, Jr., Director, National Cancer Institute
Lewis Thomas, M.D., Symposium General Chairman
John Ultmann, M.D., Symposium Vice-Chairman

Symposium Session Chairmen
Session I Keith R. Porter, Ph.D. - The New Anatomy
II Philip Leder, M.D. - Organization of Genetic Material
III James D. Watson, Ph.D. - Regulation of Gene Activity
IV Howard Green, M.D - Cell Growth, Movement and Differentiation
V Daniel Nathans, M.D. - Viruses in Aging and Cancer
VI Baruj Benacerraf, M.D. - Immunology
VII Professor Francois Jacob - Cancer as a Failure of Normal Differentiation
VIII John Cairns, M.D., Ph,D. - Aging and Cancer as Genetic Phenomenon

OPENING REMARKS

Congressman Pepper- purpose of session to identify what Congress might do to assist in the struggle against cancer- persons over age 54 constitute 81% of all cancer deaths

- our investment of$1.1 billion in cancer and aging research (NCI and NIA, FY 81) is 'woefully inadequate' when compared with $6 billion currently appropriated for national defense
- expressed appreciation to the Bankers Life and Casualty Company of Chicago and the Retirement Research Foundation for their assistance in funding the Symposium; and to Drs. Butler and DeVita and their respective Institutes for guidance in developing the program
- introduced members of the House Committee who each made brief remarks supporting the aims of the hearings and expressed appreciation to Mr. Pepper for his significant role in the genesis of the Symposium and the proposed follow-up Workshops.

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*Summary statement prepared for Dr. Ringler's presentation to the National Advisory Council on Aging meeting, January 29, 1981.

OPENING REMARKS, con'd.

Dr. Thomas, Chancellor, Memorial Sloan-Kettering Cancer Institute

- reviewed complementary nature of this Symposium with one sponsored September 14-20, 1981 in New York by Memorial Sloan-Kettering Cancer Center (and aided by the American Cancer Society and the NCI) dealing with advances in cancer therapy developed during the 1970s applicable for the improvement of our capacity to cope with the disease in the coming decade.
- New York conference concluded with a sense of optimism and accomplishment, particularly in regard to treatment of the leukemias and other formerly devastating malignancies of childhood and young adults; breast cancer; cancer of the rectum; and a beginning of successful treatment for cancer of the lung.

  This optimism accompanied by a general consensus that we do not know enough; we need to understand more clearly the underlying mechanisms involved in aging and in cancer.
- regards the Symposium as the most exciting and astonishing of any gathering within his professional experience.
- results of research laboratory investigations in the U.S. and elsewhere during the last few years have transformed biology so that we are beginning to understand the intimate aspects of the living cell; and now have the means to manipulate some of the mechanisms in order to find out exactly how they work in ways which were unimaginable just a few years ago.

  Present knowledge is sufficient to enable scientists to ask penetrating questions; and, the hardest part of all tasks in research is to ask the right questions. The second most difficult task is to recognize and accept surprise when it turns up. This is the kind of science discussed at the Symposium.

  Examples cited:

  using high voltage electron microscopy, it is possible to take pictures of the molecular structure of cells; genes can be seen with the human eye and their positions mapped on individual chromosomes precisely.

  recombinant DNA technology permits insight into the mechanisms by which genes function to switch on to make a certain protein or are switched off.

  we are beginning to see how parts of the mechanisms directing gene function fit together, how the rearrangement of genes from one place to another can introduce nearly infinite variety in the antibodies coded for and some of the ways in which this system can make damaging mistakes.

Dr. Thomas, con'd.

- his view of the biological significance of aging and cancer:
  - (1) all cancers are a closely related set of biological accidents, diseases, not in any sense inevitable or natural. We are now in a position to begin learning the fine detail underlying the mechanisms responsible for the transformation of normal cells to neoplastic cells- whether by virus, carcinogen or spontaneous. When we have acquired enough information, we will be able to control the process, reverse it, or prevent its occurrence.
  - (2) aging is a natural process, but the disabling and humiliating diseases that now beset so many of the aged are not natural or inevitable. The real problem of aging is the susceptibility to a whole array of superimposed diseases late in life. What we need is a better understanding of the mechanisms involved in this vulnerability.
- biological science is rapidly turning into a single coherent field filled with subspecialities, but made coherent by the intuition that the advances made in any single specialty are almost immediately relevant to other fields. What ever we learn about the process of aging or cancer will have meaning for the other and also have meaning for other problems in biomedical science, i.e. rheumatoid arthritis, multiple sclerosis, heart disease, Alzheimer's disease, etc.
- we have reached today's level of understanding and the opportunities for the discoveries that lie just ahead because of basic research begun 30 years ago at a time when no one had the faintest notion that such work would ultimately become useful.
- matter of greatest national significance that we maintain and sustain this country's strength in all areas of science

Major issues for Committee's concern:

- scientific research has become a very insecure career- fellowship money is far scarcer than it used to be and duration of awards is too short to allow for the completion of projects begun; stipends are far too low compared with comparative professional employment opportunities. Also, the intense competition for limited funds for basic research means that the young scientist is not likely to take chances in the design of research plans, for fear of not having solid results by the time he must reapply for funds to continue, often just eight months after his initial award is received.
- result is that we have fewer talented young people going into science today; and, there is a growing tendency for them to limit their aims to 'short-order' research.
- universities and research institutions nationwide are deeply worried about the obsolescence of their instrumentation and equipment. Funds for the construction of special housing needed by some types of sophisticated equipment are especially difficult to obtain.

598 - as a result of these inadequacies, the U.S. is beginning

Dr. Thomas, con'd.

to lag behind Europe and Japan in the capacity to mount the kind of high technology program need for today's basic research.

Item #1

More money is needed for the basic research of the future and for young scientists who must be free to use their minds and imagination freely.

Item #2

More funds are needed for modernization and renovation of scientific equipment and instrumentation and facilities for their use.

Item #3

Additional funding is needed for foreign investigators and laboratories to encourage mutually beneficial continuing and broader collaborative research programs.

(Every session at the Symposium included scientists from abroad making evident that a close collaboration exists between scientific groups in the United States and virtually every other scientific center in the free world. This transnational research phenomenon should be assisted whenever the opportunity arises by a greater investment in those foreign laboratories working in close collaboration with those in the U.S.

Dr. Butler

- emphasized value of the Symposium as a collaborative venture between the private and public sectors; and, the commitment of the NIA, which is shared by the NCI to continue the tradition of this Symposium by utilizing the NIA conference grant mechanism to support follow-up targeted workshops.
- further areas of collaboration between the NIA and the NCI identified include:
  1. relation of pharmacology of aging as it bears upon use of chemotherapeutic agents in the treatment of the elderly.
  2. nutrition and its relation to molecular and cellular biology.
  3. design of more effective clinical protocols to evaluate various diagnostic and therapeutic modalities of tumors having a high incidence in the elderly.
  4. the making available, as funds permit, of genetically characterized aging and aged animals for study of aging/cancer interrelationships and the occurrence of various naturally occurring cancer in animal species.

Dr. Butler, con'd.

5. the relationship of environmental pollutants to the incidence of cancer and the occurrence of other diseases in the elderly.
6. management of pain.

Dr. DeVita

- recent findings resulting from NCI programs relating to improving results of therapy and cancer prevention in the aged include:
    - a. making treatments less toxic
    - b. based on the interest of the House Select Committee on Aging, the NCI began last year to develop a modified biological response program directed toward the identification of natural materials produced by the body's own cells which are found to have therapeutic value.
    - c. use of a combination of radiation, surgery and chemotherapy for treatment of cancer of the rectum, a common disease of the elderly.
    - d. possible role of nutrition to etiology of some cancers since certain types occur with much greater frequency in specific parts of the country, i.e. cancer of the colon has a higher incidence in northeastern U.S. than in Florida.

Dr. Ultmann

- discussed following ingredients leading to successful research: young people contemplating entering the profession of scientific research today are discouraged when they look to the role models of successful researchers because of the many problems they have in trying to continue their work.
  Left alone, creative imaginative people will be able to develop programs which will lead not only to anticipated results but also to the unexpected which may be far more significant. Programs which are certain to yield expected results are less likely to give the investigator the chance to see the unexpected.
  The upgrading of technology is essential.
  The machinery required for research needs steady support which does not waiver or diminish.
  Results come with patience. Permissiveness gives the creative process the unique opportunity to persist, to follow new directions, and to make possible the right moment for the serendipidous to occur
- given this understanding of what make scientific progress possible, it is hoped that the Committee will assist in its continuation.

STATEMENTS OF SESSION CHAIRMEN*

Dr. Benacerraf

- stressed growth of immunology and usefulness of advances in this discipline to all others
- supports Dr. Thomas' view that these advances were made at a time when support of science was more optimistic than it is today
- emphasized recruitment of talented young people severly compromised because of present situation (discussed above) especially in the case of young physicians who need training in basic science discipline if they are to further advance medical science and practice
- present problem results from the fact that due to a lack of sustained and continued support, young people, no matter how dedicated, do not preceive that there is an opportunity for them. Accordingly, they are discouraged from starting because of lack of opportunity and hope
- urges Committee to understand the fact that 6-8 years of post-doctoral training are necessary for the adequate preparation of those going into biomedical research

Dr. Cairns

- stressed the value of epidemiological studies in providing information applicable to reducing the death rate and incidence of cancer. Such studied have:
  1. detected the compounds in synthetic rubber industry causing bladder cancer resulting in a change in synthesis methodology which has since eliminated bladder cancer with this etiology.
  2. discovered the carcinogenicity of asbestos which resulted in changes in manufacturing regulations which elininated disease from this cause
  3. discovered the association between cigarette smoking and lung cancer

Item #4

In addition to support of basic biological research, support of epidemiological studies is vital.

Dr. Green

- stressed the need for improvements in the technology of tissue culture, ie.e. the chemistry and physics of the culture media, growth nutrients from various sources, etc.

Dr. Jacob

- impressed by the fact that some kind of unity beging to appear in biology evidenced by the sum total of the various research areas discussed at the Symposium.

- stressed importance of ontological studies and the relation of the normal developmental process to aging and cancer

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* Please see page 14 for roster of Session Chairman which also states their professional affiliation

Dr. Jacob, con'd.
- supported Dr. Thomas' view of the importance of support for basic research and the training of young people
- an important reason for the linking of laboratories is that as science progresses, more and more types of experimental approaches have to be put together

Item #5

It is extremely important to strengthen the international relationship between Europe and the United States by various means including increasing the possibility for scientists to work in one another's laboratories.

Dr. Leder
- emphasized the remarkable and revolutionary advances now within the realm of possibility as a result of application of recombinant DNA technology. Use of these techniques has already resulted in two unexpected outcomes: a detailed picture of the genes of man and higher animals which could not have been anticipated from classical genetic studies using methodology available over the last century; and, the beginning in the United States and throughout the world of an industry and industrial processes which could not have been imagined as shortly ago as five years (for the development of pharmacologic products and drugs as well as other kinds of industrial products). Each of the above developments has direct applications in terms of providing insights regarding the problems of cancer and aging.
- a decade ago, it would have been almost impossible to imagine that research carried out on a bacterial virus would ultimately be relevant to the isolation of agents such as interferon useful in the treatment of certain viral diseases.
- stressed the need for support of basic research, since the nature of our discoveries cannot always be deduced by pure reason and we must await the unexpected.
- support for young people who must be continually drawn into the various biomedical disciplines should be strengthened both in the numbers of fellowships available and in the quality of life they can lead while receiving such support. A more realistic subsistence stipend would play a significant role in encouraging them to take the risks necessary in the pursuit of the answers we seek.

Dr. Nathans
- stressed the unity of basic biology and the fact that in studying cancer, scientists are also studying normal cells and visa versa; and the importance of young people in the entire present and future research enterprise.
- main substantive finding in his session was the report that many viruses cause cancer in animals of a type that resembles human cancer do so because they have somehow picked up genes from entirely normal cells which, when they get back in the form of a virus into another cell, somehow trigger the entire pathologic mechanism.
- the entire creative effort which we have reason to believe will teach us a great deal about normal and cancer cells is dependent on sustained support of training programs and young investigators.

Dr. Porter - described the usefulness of high-voltage electron microscopy in providing valuable information about cells, their movement, how they control their shapes, polarity, and intracellular transport. Much more would be known if we had 3-4 more of these instruments in various parts of the country. This and various other research tools have been developed abroad indicating that we have lost our independence in design and marketing of such instrumentation; we are not now even training young designers and engineers in this kind of work and nothing is in progress to ameliorate this situation

Item #5

Steadily increased funding for instrumentation is needed to replace the outmoded and inadequate instruments currently available; and, a greater investment is needed in young people who can be trained as engineers and designers in this field.

Dr. Watson

- the field of aging needs a great deal more of basic research before that biomedical area will achieve the degree of sophistication now characterizing scientists working in the field of cancer research.
- compliments the leadership of the NCI which has recognized the need for an investment in basic research in order to get the fundamental facts of biochemistry, genetics and biology; such emphases should also be employed by the NIA as our focus should be complimented by knowledge of normal cells
- emphasized the scope of the incredible revolution occurring as a result of applications of recombinant DNA techniques allowing the merger of molecular biologists and molecular geneticists to provide kinds of information which were unimaginable even five years ago.
- not only should we celebrate the past but through support of the best of basic science today, we can provide a framework within the next 20 to 30 years so that remarkable advances in research in aging will be a reality.

QUESTIONS FROM COMMITTEE MEMBERS TO DR. THOMAS, SESSION CHAIRMAN, DR. BUTLER AND DR. DEVITA

1. Questions from Mr. Biaggi

   a. In answer to the question of why more young people are currently not involved in training for, or conducting scientific research. Dr. Thomas stated that such a career is now typified by chanciness and unpredictability because stipends are currently far below a realistic level; there is intense competition for the limited funds available; and a mountain of paperwork is required for the submission and maintenance of financial support. A shortage of opportunities for those with combined M.D. Ph.D. degree preparation encourages such individuals to go into private practice.

b. How does the United States compares in governmental participation in scientific research compared with other nations? Dr. Thomas stated that up to the past 5-8 years, the role of the Federal government in the development of science has far outdistanced that of any other nation. However, since that period, we have reduced our investment while at the same time Europeans, Japan and the Soviet Union has increased thier investment.

c. In answer to the question regarding the present degree of international cooperation. Dr. Thomas referred to a meeting held by the symposium planning committee in which 9 specific scientific areas were designated as agendas for workshops to be held during the next several years which will involve established scientists as well as those entering the field.

d. With regard to funds needed for construction. Dr. Thomas called attention to the special housing need for certain kinds of instrumentation; as well as funding needed to revitalize the physical plants of various universities and research institutions which have been deteriorating over the past ten years. Dr. DeVita responded that an estimate of $25 million for the next ten years, arrived at by a study of the NCI's advisory board, was part of the NCI's initial budget prepared for submission to the President. This however, was substantially reduced in the version of the budget prepared for Congressional consideration.

e. Dr. Jacob stated that the 20% increase in research funding which occurred recently in France was mainly the result of an executive initiative.

f. Mr. Biaggi commented that some means must be found to decrease the amount of time and effort required by research scientists for the completion and monitoring of grant proposals and grant-supported research, particularly since this was such an important factor in turning off physicians from entering prospective research careers. Encouraged Chairman Pepper to have the Committee's staff address this issue with the responsible parties.

2. Questions from Mr. Bonker

a. In answer to question regarding the feasibility of a world wide effort, Dr. Thomas stated that as far as the nature of science, there are no national boundaries. Neither Dr. Jacob nor Dr. Cairns could give any definitive data and the amount of funding for scientific research. It appears that such funding is increasing from year to year. Dr. Jacob said that funding for microbiological research in France had been increased some 18% in 1981 over 1980.

b. Dr. Butler answered a question regarding the relationship for research which would incorporate advances in preventive medicine with reductions in expenditures for medical care by stating that 55¢ of every Federal dollar devoted to health goes to the health of the elderly.

c. Dr. Butler analyzed cost effectiveness of more knowledge to prevent hip fractures estimated to cost the nation $2 billion annually--just for this one disease entity; also nursing home costs due to senility. Currently about 0.001% of funds going for Medicaid and Medicare goes into work which relates to research on aging. "If we do not find any new knowledge that helps assist us in preventing or ameliorating various forms of senility, we are going to have an incredible escalation of nursing home costs estimated by the HCFA to be in excess of $75 billion by 1980. Research is the ultimate cost containment as well as the ultimate service because it is the only means by which we can ultimately achieve disease prevention."

3. Questions from Mr. Lungren

a. In answer to a question regarding the private sector's participation in basic research the areas of cancer and aging, Dr. Thomas stated that most of the participation by universities and research institutes is federally funded. Philanthropic foundations are beginning to exhibit more interest in the needs for basic science. Thomas would like to see something more in the way of partnership arrangements between industry and academic science that would benefit each.

b. Mr. Lungren then questioned whether federal support was in any way decreasing the aggressiveness on the part of the private sector, particularly the drug industry, in areas that could have application to aging in cancer research? Dr. Thomas stated that within the past few years a number of university scientists have moved into positions as Directors of R & D for various pharmaceutical companies. This factor alone is resulting in closer working relationships. This is helpful on the short-range view, but what is really needed is long term partnership arrangements wherein university and industry scientists can pool their resources.

c. Mr. Lungren stated that frequently the startup costs of some technology, i.e., brain scanner, is so great and the initial applications not entirely evident, especially in terms of long range benefits, legislators are apt to interfere with their development. One of the problems has been that legislators have not viewed the long range benefits of basic research either in medicine or in the area of industrial technology.

d. Dr. Thomas then responded to the question of identifying new applications of treatment for cancer developed during the last decade.

(1) beginning to achieve actual cures in the treatment of Hodgkin's disease, a type of cancer previously 100% fatal
(2) about 50% of acute childhood leukemia is now cureable
(3) though some progress has been made in cancer of the breast and lower intestinal tract, we are still lagging behind in the treatment of many types of solid tumors, the most common type in adults.
(4) recombinant DNA technology is now making possible the manufacture of the purest kind of interferon which can now be evaluated as a therapeutic modality
(5) the same technology which is capable of providing other kinds of pure antibodies useful as research probes in various immunological problems both for basic biomedical research and for various industrial applications as well

e. Dr. DeVita estimated that about 40,000 patients a year are now living from cancer as a result of chemotherapy treatment alone or in combination with each treatment modalities. Each cohort now being successfully treated by these means brings into the economy approximately $2 billions or $500 million annually in taxes (conservative estimate).

GENERAL DISCUSSION

Chairman Pepper recognized Mrs. Mary Lasker and commented on her many contributions in alerting the public and the Congress to the country's many needs in the area of biomedical research to improve the health of the American people; and her role in working with him and others in bringing about this Symposium.

Chairman Pepper questioned Dr. Thomas regarding how the Committee could best advance the cause of research into aging and cancer, appropriate current funding and funding for the years following.

Dr. Thomas responded that although dollar funding for research has increased in the last decade, constant dollars, allowing for inflation, have actually decreased. Forgetting about this lag period during the last 8 or so years, a 5% growth per year over and above inflation, would be realistic. This would mean an 18-19% growth of the FY 81 budget for the FY 82 research budget. In order to bring the physical plants of universities and private research institutions up-to-date with instrumentation, equipment, and the construction and renovation needed for modernization, estimates are that between $100-200 millions will be needed for the next few years. An annual sum of $25 millions alone is perceived as necessary to meet the needs for cancer-related research.

In answer to Chairman Pepper's question regarding the percentage of basic research relevant to cancer being funded outside NCI, Dr. DeVita stated that NCI makes up 27% of the total NIH budget, so the figure Dr. Thomas mentioned should be pro-rated up for the entire NIH. Much basic research supported by the other Institutes is relevant to the NCI.

Dr. Thomas and Dr. DeVita agreed that the $100 millions for instrumentation and modernization of physical plants should go through the NIH for disbursement. Dr. Thomas again reminded the Committee that the stipends of the existing fellowship programs are unrealistically low and too few in number to meet the need. This is particularly true of the Research Career Development Awards in which all Institutes participate. Dr. Benacerraf strongly concurred and recommended that strong support also be given to M.D./Ph.D. programs in medical schools. The fact that the RCDA stipend is currently $14,000-15,000 per year means that the average resident has to take a 30% drop in stipend level if he elects use ofthis route as a career development mechanism.

Mr. Biaggi stated that members of Congress were unaware of these details and would surely respond favorably if this information were brought to light.

Dr. Ultmann responded to Mr. Bonker's and Mr. Lungren's comment about cost effectiveness stating that the balance of prolonged hospitalization for a multitude of ineffective diagnostic tests against the cost of a CAT scanner is enormous. If we look at today's expenditures for basic research and forget about tomorrow's cost effective savings which such research will achieve, we are going to have to face-up to the lost opportunities which will cost us ever so much more in dollars, human suffering, and forward progress in the advancement of the best quality of life possible for our citizens.

GENERAL DISCUSSION, con'd.

Cngressman Pepper concluded by stating that some of those present testifying today would be invited to testify before the coming Appropriacion's Committee Hearings. He then spoke of an appropriation of $100 millions that was authorized by the Congress to be used to further advance any breakthrough identified during the Symposium. He then asked Dr. Thomas if he could identify any such idea or proposal which came to light during the meeting. Dr. Thomas stated that he and the Session Chairmen would like to think further about this point and would welcome the opportunity of reporting back to the Committee.

Congressman Pepper recognized that more than twenty countries were actively involved in the Symposium program; that this working together represented a strong cohesive force against the 'monster' threatening us all: and, that this unity of action would continue in future planned workshops and conferences.

1/27/81 MA

RESEARCH FRONTIERS IN AGING AND CANCER

INTERNATIONAL SYMPOSIUM FOR THE 1980's

Symposium Honorary Chairman

Congressman Claude Pepper
Chairman, House Select Committee on Aging

General Chairman

Lewis Thomas, M.D.
Chancellor, Memorial Sloan-Kettering Cancer Institute, New York

Vice Chairman

John E. Ultmann, M.D.
Professor of Medicine and Director, Cancer Research Center
Pritzker School of Medicine, The University of Chicago

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Department of Pathology
Harvard Medical School

John Cairns, M.D., Ph.D., Chairman
Imperial Cancer Research Fund
London

Howard Green, M.D., Chairman
Professor of Cell Biology
Massachusetts Institute of Technology

Francois Jacob, Professor and Chairman
College de France
Institute Pasteur, Paris

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Daniel Nathans, M.D., Chairman
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Johns Hopkins University

Keith R. Porter, Ph.D., Chairman
Department of Molecular Cellular and Developmental Biology
University of Colorado

James D. Watson, Ph.D., Chairman
Director, Cold Spring Harbor Laboratory
New York

RESEARCH FRONTIERS IN AGING AND CANCER

INTERNATIONAL SYMPOSIUM FOR THE 1980's

Principal Recommendations to the House Select Committee on Aging from Symposium Chairmen and Session Chairmen

1. More money is needed for the basic research of the future and for young scientists who must be free to use their minds and imagination.
2. More funds are needed for modernization and renovation of scientific equipment and instrumentation and facilities for their use.
3. Additional funding is needed for foreign investigators and laboratories to encourage mutually beneficial continuing and broader collaborative research programs.
4. In addition to support of basic biological research, support of epidemiological studies is vital.
5. It is extremely important to strengthen the international relationship between Europe and the United States by various means including increasing the possibility for scientists to work in one another's laboratories.

RESEARCH ON AGING AND ORAL HEALTH: AN ASSESSMENT OF CURRENT STATUS AND FUTURE NEEDS[*]

by

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[*] Prepared for the 1981 White House Conference on Aging.

Introduction

Current predictions of the age distribution in our population suggest that there will be a dramatic increase in the proportion of older persons in the next 50 years. While in 1970 approximately 10% of all Americans were over age 65, it is expected that by the year 2020 this group will represent a full 20% of our population (1). This remarkable demographic shift introduces a challenge to our society: meeting the multiple and varied needs of the elderly.

One aspect of this challenge lies in health care delivery. Of particular concern is the high prevalence of disease among the aged and the associated cost for its treatment. Those charged with the provision of health care services have recognized that current circumstances are inadequate to respond to a burden such as this.

One approach to lessening this burden would be through research; increasing our understanding of the health problems of the aged. Many laboratory and clinical disciplines have joined in a flurry of research activity in recent years. Significant advances have indeed been made. However the single most valuable contribution has probably been the recognition that aging and disease are different (2). Acceptance of this distinction has allowed (and in fact mandated) the separate description of physiological functions during aging and the pathologic compromises of "normal" function imposed by disease. Furthermore it has compelled geriatricians to examine past data with a more critical eye, forcing them to re-evaluate many previously accepted "truths".

In this latter endeavor some disciplines have proceeded further than others. Dentistry has been among the relatively slow responders. It is the principal objective of this paper to address this problem directly by providing a review of available data on aging and oral tissues as to scientific merit and thus suitability for general application. Hopefully this will aid in focusing attention on the existing information gaps within geriatric dentistry, and in so doing stimulate research activities in these areas.

The Aging Oral Cavity

Anyone interested in learning about the status of the oral cavity with increased age can find, in numerous texts and reivew articles, a fairly consistent description of oral tissues during aging.[1] In fact, the degree of uniformity is so remarkable that a ready series of generalizations about this topic can be made. Like so many other areas of geriatrics, dentistry is confronted with a number of stereotypes which have been repeated so often that they are now simply accepted as fact. A listing of some major generalizations associated with aging and the oral cavity can be found in Table 1. Though the range of critical commentary on these topics varies widely, broad acceptance is usually the rule. One can come away from some readings feeling confident that every aged person will likely have no teeth, a dry mouth, reduced masticatory efficiency, altered taste, friable mucosa, etc.

How valid are these generalizations? In the section which follows, major generalizations are addressed separately, and the actual data upon which they have been based are evaluated. Where appropriate discussion of the original experimental questions asked, design concerns, methodology, etc. will be considered. As noted above, particular emphasis will be placed on the separation of aging physiology from pathology. Obviously, an exhaustive review of each paper available is impractical. Representative works will be cited and some indication of the extent of actual investigation on each topic will also be given.

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[1] I have read 17 such treatises, spanning the last 20 years. My comments are based on this effort. Representative references include 3-9.

A. Oral Mucosa

Generalization: Atrophic changes occur. Clinical appearance suggested to be as pale, dry tissues apparently more "abradable" by physical stress. Some symptoms have been associated with these alterations (especially among post-menopausal women). These include mouth dryness and sensations of pain or "burning" on the tongue and buccal mucosa.

The studies available for comment include clinical, histological and cytological observations. One of the earliest and most frequently cited studies (Richman and Abarbanel, 10) reported findings from 25 post-menopausal women. Their clinical and histological observations of buccal mucosa are well described by the above generalization. The study appears to be a careful exposition of their experience. However there are at least three design considerations which restrict the extent to which these results may be generalized. First, the individuals studied are clinic patients and thus not a representative population sample. Second, no medical histories, indications of complicating pathologies, nutritional state or medication index is given. Finally there is no control group of pre-menopausal women and thus no basis for within experiment comparisons of subjective judgments made. The results suggest that, at least among a restricted population, oral muscosal changes occur. It is unclear how frequently these changes occur and whether they are due to disease or to physiological menopause.

Shklar has presented retrospective histological data from 300 samples of oral mucosal biopsies (11). He suggested that significant differences exist between individuals less than 16 years of age, and those older than 60 years. Specimens from individuals 25-50 years old were "intervening" in appearance. Changes reported (with the older group) include thinner epithelium, more keratinization and increased levels of epithelial carbohydrate. No sex differences were evident. In this study, no characterization of patients was given. This leaves the question of the normalcy and representativeness of the observations unanswered. Further, because of its retrospective design, there is no information available on clinical appearances and associated symptomatology. These deficits make interpretation difficult and restrict the usefulness of this study.

Nedelman and Bernick (12) recently reported histologic changes in the oral mucosa, covering edentulous alveolar ridges, from eight necropsy specimens (aged 72-92 years). The changes reported are similar to Shklar's findings. In addition these authors note frequent arteriosclerotic changes in mucosal arteries. As in other cited studies, no medical histories or clinical symptomatology are given. Additionally, since we know that the samples are from mucosa overlying edentulous bone, they are likely not normal mucosal tissues. All subjects wore complete dentures, but their frequency of use, as well as the suitability of denture fit, were not reported. Another limitation of the report is that tissue from a dentulous 14 year old was used as a control.

Several cytological studies, correlating the degree of keratinization of the oral mucosa with age, have been reported. The results are inconsistent. Some confusion may be due to different sites of sampling (13). Also, in some instances (14,15) subjects were poorly characterized. In two studies (13,16) which use "suitably described subjects" and similar techniques, different results were observed. Most studies seem to conflict with Shklar's histological findings of increased oral mucosal keratinization with advanced age. Many reports provide no information on patient complaints or the clinical appearance of tissue. Stone (15) does mention anecdotetally that in his sample (institutionalized men 60-100 years old) an increase in mouth dryness, and a loss of tongue elasticity, were apparent.

Conclusions: There is a paucity of useful data describing the status of the oral mucosa during aging. The information which exists is usually flawed. The problems I describe in relation to these selected studies are in fact representative of difficulties observed generally in the geriatric dental literature. Typically these involve population selection. Subjects may not be representative, not well-described, of questionable health or nutritional status. Comparisons are often made without appropriate controls. Furthermore there is incredibly little reliable epidemologic data defining the existence of a clinical problem.

The methodologies used for assessing oral mucosal status are limited. Essentially an examiner can obtain a biopsy or cytologic smear and/or clinically evaluate the tissue. Of special concern is the lack of adequate means to assess the *in situ* appearance of the mucosa. For example, how does one measure atrophy or abradability? What are acceptable criteria for defining dry mouth? There is real need to develop proper tools for investigation.

It is hard to determine whether aging *per se* has an effect on oral mucosal tissues. The "problems" reported could be due to disease, inadequate nutrition, pharmacologic therapy, etc. Select populations of the aged apparently demonstrate clinical symptomatology. However, we can say little about its general prevalance, clinical course or management.

B. Dental Caries

Generalization: Dental caries among aged individuals is not a particular oral health concern. Several review articles devote little or no comment to caries in the aged. There is however widespread acceptance that cervical caries (root surface caries) is more prevalent among older persons.

If one stereotypes the dental status of older individuals as substantially or fully edentulous, it is easy to ignore dental caries as a health problem for the elderly. Although the recent National Health Survey (17) estimates that approximately 60% of all Americans aged 65-74 years have at least one edentulous arch, this figure really reflects upon a time of more primitive dental public health measures, less sophisticated preventive dental therapy, and low public awareness of factors which improve dental health. We should expect a marked reduction in this statistic within one or two generations. We can assume that in the not too distant future the mouths of older individuals will contain more teeth susceptible to carious attack.

What do we know about caries in the aged? Most available data (and it is meager) focus on cervical caries and do not include information about coronal (clinical enamel crown) caries. Interestingly, in one of the few studies available, Chauncey *et al.* (18) have pointed out that if coronal caries prevalence (both new surface and recurrent) is normalized to number of teeth present, older individuals actually have a higher caries prevalence than most adult age groups. Data here was based on a "healthy" sample of urban males. Cervical caries unfortunately was not considered by them, and this probably means the caries scores were underestimates.

Epidemiologic data on cervical caries suggests a higher prevalence of this condition in older individuals. A study by Sumney *et al.* (19) examined about 300 dentate subjects (having at least 20 natural teeth present), with good dental care, between the ages of 30 and 60. About half of those seen were affected by cervical caries (restored or active). The percentage affected increased significantly with higher age group. In an outpatient population the authors observed a frequency of cervical caries (per tooth available) twice as high among individuals 50-59 years old compared to those 30-39 years old. The principal shortcoming of this work is that the population surveyed was limited. It appears to have been carefully done.

In a larger population survey (~750 patients from dental school clinics) the percentage of subjects affected by cervical caries was similar to that of Sumney *et al.* and increased with age (20). Careful description of the population involved was not given in this short report.

Recently, Banting *et al.* (21) presented data on a small group of residents at a chronic hospital. More than two-thirds of those studied exhibited root caries, and the prevalence was significantly related to age. The authors point to the limitation of the special cohort which they examined, but their effort is an example of a careful approach to the problem. Banting *et al.* also comment on the lack of attention paid to this type of caries, noting that the WHO basic oral health assessment form makes no provision for scoring cervical caries. If this type of decay is not recorded, incorrect underestimates of caries in an older population would result.

Little is known about the etiology of cervical caries. Based on certain demographic information, it is possible to hypothesize that differences exist between coronal and cervical carious processes (19). There has been very limited study of microbial ecology in the oral cavities of older individuals (22-24). Some differences between the bacteria isolated from cervical and coronal lesions have been noted but similarities also apparently exist. No conclusions can be drawn about the oral microbial population in the aging individual, and its possible uniqueness with respect to cervical caries.

Conclusion: Failure to consider dental caries as a real oral health problem in the aged would be misleading and detrimental to oral health planning for this population subgroup. Available epidemiologic data, while not abundant, support [illegible] that per available tooth older persons have a consequential level of caries. Whether coronal or cervical, new or recurrent, caries represents a significant dental treatment effort. In terms of cost for services, especially to those with limited resources, this could be a concern. It is interesting that the National Health Survey does not provide data on cervical caries (17). Also, there appears to be no adequate estimate of the incidence of both coronal and cervical caries in adult age groups — a well described, community-dwelling population.

In addition to needs for descriptive demographic data, there appears to be a special need for laboratory studies on the oral microbial flora of the aged individual and its relationship to cervical caries. Both major dental disease entities, caries and periodontal disease, are usually bacterial in origin. There are, however, very few studies which address the oral bacterial ecology of the elderly. Given the central role for bacteria in the dental disease process, this is a glaring deficiency.

C. Oral Motor Behavior

Generalization: The oro-facial musculature atrophies with increased age. Muscle tone is reduced; the muscles of mastication and deglutition are diminished in function.

Within dentistry, concern for changes in oral motor function during aging has typically been focused on questions most relevant to the edentulous individual (*e.g.* adaptation to dentures, masticatory efficiency with dentures) (25). While not unimportant, this certainly should not be the only area of concern for the geriatrician (see above comments on the proportion of edentulous individuals in our society). The oro-facial musculature participates in a number of daily life functions important to both dentulous and edentulous individuals including: posture (intra- and extra-oral), swallowing, chewing and speech.

A survey of available data reveals little information on these functions. Most studies relate to edentulous subjects. As with other oral function studies, the authors frequently do not provide adequate medical histories. Thus, it cannot be determined whether observed alterations result from pathological conditions or "normal" physiologic situations. An additional problem is the comparison of individuals in different age groups who have different dental states. Often appropriate control subjects (edentulous young) are not used. For example Grasso and Catalonotto (26) recently reported a decline in oral sensorimotor skills (stereognosis) occurring with increased age. Dentulous younger subjects were compared to edentulous older ones. The effect of long term palatal coverage on stereognostic ability was not considered. As a result their findings may be biased and difficult to interpret.

Very limited information is available on motor performance among substantially dentate, "healthy" persons (25). Feldman and colleagues (27) recently reported a study on masticatory performance in "healthy" men of different age groups. Among individuals, with comparable dentitions, masticatory effort (ability to chew a food bolus) was unchanged with age. However, there was a significant change in chewing efficiency (time required to chew food in preparation for swallow). A significant increase in preparative time was observed with subjects in older age groups. An additional observation by these workers was that tooth loss correlated with an increase in the food particle size which a subject was willing to swallow. Among edentulous and partially dentate individuals this could conceivably be manifested in choking difficulties.

Our own studies (25) utilize a different approach. We draw our subjects from the cohorts of the Baltimore Longitudinal Study, an essentially "healthy", community-dwelling population. Each subject receives a physical oral motor examination (28) which evaluates some 35 aspects of the oro-facial musculature, "grouped" about four function areas (Lip Posture, Tongue Stability, Swallowing, Chewing). Our results suggest that with older age groups, a higher prevalence of altered motor functions exists. For example, lip posture impairment (which is concerned with drooling and chronic inflammation of the labial fornices) is much more frequent in older individuals, while impairment of swallowing is only modestly more frequent in these persons. We are currently attempting to provide a more objective measure of oral motor functions in our subjects by using ultra-sonic methodology.

Conclusion: One is unable to make a generalized assessment of the status of the oro-facial musculature with age. There is not enough data upon which to base a general conclusion. Atrophic changes apparently occur in certain selected population samples. Whether such changes are due to disease alterations or physiological conditions cannot be ascertained.

Obviously more clinical investigative effort is needed. The oral musculature participates in many critical daily functions. Subtle impairments in performance could have marked consequences for the older person (25). Problems, if they exist, must be identified, and treatment modalities developed.

One particular obstacle to such an effort could be the lack of adequate, objective methodologies for evaluating patients. Approaches used by Feldman *et al.* (27), as well as ourselves, are helpful in this regard, but more convenient tools (suitable for application by the practitioner) are needed.

D. Salivary Glands and Saliva

Generalization: There is a diminution of salivary gland function with increased age. Quantitative and qualitative decremental changes in the salivary secretions result. Older individuals, in part because of this, frequently suffer from xerostomia (a dry mouth).

There have been many studies reporting age-related changes in the morphologic appearance of human salivary glands (*e.g.* 29,30). Although the health status of the individuals from whom the tissues were obtained is often not given, comparable results have been seen by many investigators. There is general agreement on the following findings: (1) increased infiltration by fat and connective tissues replacing gland parenchyma, (2) accumulation of autophagic granules (lipofuscin granules), (3) presence of an altered cell type, oncocytes.

However there is relatively little information and little agreement on the functional correlates of this altered structure. The primary function of salivary glands is the exocrine production of saliva. Saliva is of critical importance to the maintenance of oral health (31). Any impairment in saliva production (quantitative or qualitative), could result in diminished oral health for the elderly.

The "simplest" measure of salivary gland function is saliva production (*i.e.* flow rate). Several laboratories have investigated salivary flow rates in different age groups, often reporting different results. Various workers have used either mixed or single gland secretions, collected at rest or during stimulation. These methodological differences make comparisons between the studies impossible (32).

Examining representative reports (33-41) will be instructive as to the problems of interpreting much of the aging/salivary gland function data. An early paper by Meyer and Necheles on this subject (33) is still frequently cited. They examined 29 persons aged 60-90 years. Most were residents of an old age home and are noted as having "showed one or another of the infirmities of old age." They were compared to 32 persons aged 12-60 years who were described as "suitable clinic patients, interns and graduate students." Whole saliva was examined following a masticatory stimulus.

There are several aspects of the experimental design of this study, which make interpretation of the data impossible. First the subjects studied are not suitable. They are not well described; the likelihood is that the younger group was "relatively healthy" while the older group, being institutionalized, suffered numerous pathologies. Obviously no description of normal physiology can result. Second, the method utilized for salivary stimulation may, in fact, emphasize non-salivary differences. It is a muscular co-ordinating mechanism (mastication and expectoration). Since a diminution in these oral motor functions may be more frequent among older individuals (25), it is an unfortunate choice of stimulus for age group comparisons. Also Meyer and Necheles analyzed expectorated whole saliva. Accurate measure of this mixed secretion is particularly difficult since a centrifugation step is required to remove debris. In addition, sputum can contaminate samples. Further it is difficult to reach conclusions about individual gland functions from whole saliva (31). Besides these specific concerns, several general experimental design concerns, recognized at present (31,32) were unknown to these investigators; for example regulation of collection times, postprandial times, consideration of menstrual status, etc. For these reasons, the conclusion of this work, that there is a marked decrease in stimulated saliva production in aged individuals, cannot be accepted.

A later study by Bertram (34) examined unstimulated whole saliva (collected by suction not expectoration) in 111 persons (31, <65 years; 30, 65-84 years who were subjectively healthy; 50, 65-91 years who were subjectively diseased). He found a decrease in average whole saliva output in the older groups; much more so in the diseased population than the healthy group. Interestingly, the range of secretion reported in the healthy older sample was still ~10 X that described for individuals who suffered from xerostomia (by Bertram same report). Thus, although unstimulated whole saliva production may be diminished in older persons, the diminution is not of the magnitude which brings about symptomatology. Bertram concludes that xerostomia is most often a symptom of systemic disease not of aging *per se*.

In our work at the Gerontology Research Center, we have investigated stimulated parotid saliva flow rate in non-medicated community-dwelling subjects, using currently accepted study design criteria. Our results demonstrate that young and old males and females are equally competent in stimulated parotid fluid output (32). Findings with post-menopausal women were particularly interesting, since this group is purportedly most affected by decreased salivary flow and "dry mouth" complaints. Non-medicated post-menopausal women had levels of stimulated parotid saliva secretion comparable to their pre-menopausal counterparts. Medicated post-menopausal women, however, show about a 25% diminution of flow rate. This suggests that some earlier observations of diminished salivary flow may have been due to pathology or pharmacologic effects on salivary glands.

Analysis of the constituents in saliva reflect another level of salivary gland function. Many organic and inorganic components of salivary secretions are important to oral health. Studies which have examined salivary constituents, from various aged individuals, report mixed findings. Meyer *et al.* (35) reported a marked decrease of amylase activity (implying amylase concentration) in whole saliva from older individuals. Amylase is an enzyme, the major constituent of parotid acinar cell secretory granules, and a useful index of exocrine protein secretion. For the reasons given earlier in discussing the Meyer and Necheles paper (33), design factors make amylase data interpretation impossible and preclude general acceptance of these findings. A relatively recent report by Helfman and Price (36) demonstrates no differences in amylase activity in stimulated parotid saliva from various aged persons. These authors tested only 23 subjects (13, 21-49 years; 10, 64-99 years). Details of the collection method (time of day, etc.) were not given. Furthermore, older subjects were institutionalized. Because of these limitations, their results must also be cautiously interpreted.

Azen (37) has reported a diminution of parotid salivary peroxidase activity with age. Peroxidase may be a particularly important component of salivary antibacterial activity. Azen however does not describe the age range or health status of his 78 subjects nor give details of the collection procedures. The stimulation of saliva, by sucking a sour lemon candy, raises the question of the effect of age on muscular co-ordination. Again some reservation in data interpretation, with respect to age, is necessary.

A few studies on electrolyte concentrations in the saliva of various aged persons have been reported. Becks (38) and Wainwright (39) reported data, from the same sample, on calcium and inorganic phosphorous (respectively) contents of unstimulated whole saliva. Caution should be injected since whole saliva contains components not of salivary gland origin (*i.e.* bacterial products, desquamated cells, etc.). The individuals studied (650) were reported free of metabolic disorders and collections were standardized to mornings, before the subjects took anything by mouth. Parenthetically flow rates in this group (up to ∿ age 80) appear not to vary with age.

A somewhat higher level of both total calcium and inorganic phosphorous was found in older individuals. For both of these electrolytes there exists a relationship between salivary concentration and flow rate (at least, within gland secretions) though it is currently thought that as flow rate increases, calcium increases while inorganic phosphorous decreases. It is interesting then that both electrolytes were elevated in whole saliva samples from older individuals. This would be unexpected unless flow rate relationships did not hold or electrolytes were from other sources.

Grad later studied sodium and potassium content of whole saliva from 108 persons, 5-99 years in age (40). Samples were collected in a uniform manner with respect to time, from subjects referred to us "apparently healthy". The cautions about whole saliva utilization for constituent analysis apply. In gland salivas there is a considerable relationship between flow rate and sodium content. This was not known at the time of this study. The author reported an increase in sodium content in older men (40-99; this is not a suitable age grouping) but not women. Potassium values were constant.

More recently, Chauncey *et al.* (41) have presented data on electrolyte composition in stimulated parotid saliva from a group of healthy aging males. Sodium, calcium and chloride levels were reported to decrease with age. Unfortunately flow rate relationships of electrolytes were not considered during analysis so the meaning of the data is difficult to discern. Also sample collection was not restricted to one time of day. Thus diurnal variations may have influenced results.

Conclusion: There is no valid support for a generalized diminution of salivary gland function with increased age. For example, under carefully controlled conditions, stimulated parotid saliva is constant across different age groups (32). Other situations (rest vs. stimulated) and other gland types (submandibular, sublingual) require further study.

Examination of specific gland constituents also yields no consistent conclusions. Very few studies have in fact been done. Of those available, many (like flow-rate studies) provide inadequate subject descriptions, experimental details, etc. and therefore preclude broad interpretations. Additionally, flow rate influences on constituent levels have not been addressed in data analysis. Methods of analysis need to be developed to consider this issue, otherwise data summaries (*e.g.* by mere averaging of concentrations) will not be meaningful. Finally, many workers have utilized whole saliva, which has many inherent deficiencies for use in salivary gland function studies. It would be much less confusing to analyze individual gland secretions especially when electrolytes are examined.

Sufficient advances in salivary gland physiology have been made to enable adequate examination of their function during aging. Rigid criteria for collection and analysis must be applied. At present most of the generalized statements made about the function of salivary glands, in older individuals, lack the necessary supporting scientific data.

E. Sensory Functions

Generalization: Taste acuity and perception are markedly decreased in old age causing the elderly to have diminished appetites, which leads to malnutrition.

Many studies have suggested that gustatory function in old age is diminished (for review see 42,43). Early studies by several workers have supported this concept. Arey *et al*, in 1935, reported the number of taste buds on circumvallate papillae decreased with increased age (44). This was especially true with tissue from elderly (≥ 74 years) individuals. In this study, post-mortem samples were used and no clinical histories of the subjects were given. It should be noted that although this data has been used to support decreased taste acuity during aging, there is no information on how many taste buds/circumvallate papilla are required for adequate gustatory function.

Subsequently, other reports, clinical in nature, have appeared. The work of Cohen and Gitman (45), an often cited study, described a large increase in subjective taste complaints by older individuals (~30% of their sample). However, all the elderly persons they examined were institutionalized and it is likely that pathologies, medications and nutritional status may have influenced the high frequency of complaints noted. Interestingly these authors point out that the incidence of taste complaints had no relationship to the subjects' performance on a taste recognition test.

A recent report by Mistretta and her coworkers (43) has carefully discussed many studies of taste in aging individuals. They describe many methodological problems found in previous work. Most reports, which examined taste thresholds, utilized procedures now considered inadequate. Concerns include lack of water rinses prior to testing tastant solutions, inadequate exposure of the gustatory apparatus to the tastant, insufficient concentration ranges of tastants tested.

Additionally, in considering possible taste deficiencies in older persons, one should ask if threshold measures are meaningful estimates of taste perception. Bartoshuk (46) has recently argued that thresholds are inadequate to define real taste function and suggested that evaluation by "suprathreshold" measures be employed. Taste thresholds measure, in effect, a "molecular event", the lowest concentration of a tastant to support taste bud stimulation and allow discrimination of a tastant solution from water alone. This is very different than the level at which we perceive tastes in daily life. "Suprathreshold" concentrations would approximate those experienced in the real world (~100 X greater than threshold concentrations). Methods are now available to reasonably measure sensitivity to suprathreshold stimuli.

In their own work, Grzegorezyk, Jones and Mistretta have carefully examined the threshold for tasting sodium chloride in individuals of varying ages (43). Although they observed an increase in sodium chloride thresholds with age, it was quite modest. The thresholds observed by these workers were much lower than those reported earlier; a reflection of the way the earlier tests were administered. Our studies utilize similar methodologies and have also observed a modest increase in sodium chloride taste threshold with age (47). In addition we have noted a similar slight increase in quinine sulfate (bitter), but no differences with sour (citric acid) or sweet (sucrose), taste thresholds.

There is no published data on suprathreshold taste function during aging. Our studies, at present preliminary because of the number of subjects (80) seen, indicate no general diminution in suprathreshold taste function with age. However, among older women, a significant alteration of the perceived intensity of suprathreshold concentrations of sodium chloride and sucrose, was found. If supported by studies on additional subjects, these findings may be of clinical import (*e.g.* diabetes, hypertension, dental caries).

In related work, Schiffman has examined food recognition by the elderly (48). She reported a significant decrease in the ability of 29 elderly subjects to correctly identify a series of blended foods, compared to 27 young college students. Elderly subjects were termed "healthy" although many were occupants of a "retirement home." She notes that patterns of the subjects' current diet may have influenced the results. Interestingly, many of the elderly persons studied subjectively commented on the weakness in taste and smell of the test foods examined.

Conclusions: There does not seem to be adequate support for the generalization that gustatory function decreases with age. Taste functions have at least two levels of necessary evaluations (threshold and suprathreshold). Current work suggests that threshold data change only modestly for some tastants, and not at all for others, during aging. There is not adequate data to evaluate suprathreshold taste function with age (clearly a need for study here).

In addition information is needed on the relationship of olfactory function, to taste, and to food recognition and enjoyment. Acceptable methodologies for taste studies seem to be currently available; this is not apparently the case for the study of olfaction.

Current Research Efforts

Only a small number of scientists (clinical and laboratory), in the United States, are concerned with the oral health of the elderly. A significant proportion of this group is concentrated in two ongoing longitudinal studies. One, sponsored by the Veterans Administration, is located in Boston at the VA outpatient clinic. The second, sponsored by the National Institute on Aging, is located at the Gerontology Research Center in Baltimore. Both studies seek to describe the oral physiological status of "healthy" individuals during aging. The VA study is sufficiently large (~1200 male participants) to supply some epidemiologic data for health planning purposes. The NIA study is about 1/3 that size and includes both males and females in approximately equal proportions. The studies share many similar "problem area" interests including gustatory function, oral motor behavior and salivary physiology. The VA study also places particular emphasis on other dental topics (*e.g.* facial skeletal patterns, variables related to periodontal disease incidence, evaluation of the efficacy of certain dental treatment modalities). Many design and methodological differences exist between the two studies.

Besides these two investigations, there are some small efforts in geriatric oral physiology, usually involving single topics (*e.g.* salivary constituents, osseous alterations, immune factors in periodontal disease, aspects of taste physiology), and utilizing a cross-sectional study design. These are "relatively" few in number. The incidence of reports of research on aging and oral physiological topics is increasing, but slowly. There is an obvious lack of activity in this field. Though interest in and an appreciation for the oral health concerns of the older individual are increasing within dentistry, this interest has not been adequate enough to generate the necessary laboratory and clinical research. In part, interest may be stifled because of the pervading stereotypes of the aging oral cavity. The dental and gerontological communities are apparently not aware of the paucity of useful information available to identify the oral health status of the aged.

Considerations

It should be apparent from this report that we, in fact, know very little about the physiology of the oral tissues across the adult age spectrum. Nor do we appreciate the problems pathology may impose on aging oral tissues. It is important, in our considerations, to keep separate these two points. The use of generalizations, such as discussed here, to describe the oral health of the elderly does not often recognize this distinction and what has resulted is a confusing picture.

It is not difficult to criticize investigations performed 20-40 years ago. Methodologies and conceptual advances have made us more "sophisticated." Such progress, however, also brings with it a responsibility — to learn from and build upon earlier works. This has not been done in the field of geriatric dentistry. Rigorous investigation is needed on well-documented individuals. Methodological approaches, necessary to address anticipated problem areas, must be developed. Tools to analyze data in a meaningful fashion should be utilized or, if need be, introduced. Carefully obtained epidemiologic data is especially needed to simply describe the status of oral tissues in aging and thus provide a basis for health care planning. The [illegible] have been stated several times above. We must cease generalizing; we have to be specific.

It also must be kept in mind that, should we discover response differences between certain age groups, we cannot quickly assign them to a catagory of negative changes, *i.e.* pathology. Physiologic systems are adaptive. What is "normal" for a 25 year old does not necessarily have to be "normal" for a 75 year old (49). Further, when a response difference is defined we must ask is it an actual oral health concern for the elderly? If it is, how can it be managed? Can it be prevented?

The research base of geriatric dentistry is meager. Encouragement and support of investigative efforts in this field are sorely needed. But caution is required if we are to clear the existing somewhat muddied water. This paper has dealt with several frequently described major "problems" of the older person. There are other concerns as well which require attention (*e.g.* periodontal diseases, skeletal changes). There are doubtless more which will become apparent as we learn about the aging oral cavity. If geriatric dentistry is to take its place as a significant professional consideration, its research basis must be expanded in a systematic and thoughtful manner.

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TABLE I

SOME COMMON GENERALIZATIONS ABOUT THE ORAL CAVITY WITH INCREASED AGE

Loss of Teeth
Atrophy of the Oral Mucosa
High Prevalence of Cervical Caries
Atrophy of the Oro-facial Musculature
Alteration in the Amount and Composition of Saliva
"Wear" of Hard Tissues
Altered Sensory Functions (Decreased Taste, Smell, Touch)

SURVEILLANCE OF HIGH RISK GERIATRIC PATIENTS

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Introduction

Improving health care delivered to elderly Americans has been in the forefront of recent federal, private, academic, and service initiatives in gerontology and geriatric medicine.* Although aged Americans are more numerous, more vocal, and more enfranchised than ever before, a substantial negativism remains pervasive in our society and adversely influences the quality of all services provided to older individuals. Nowhere is ageism more evident than in the attitudes of graduate physicians approaching clinical care of aged Americans (Akpom and Mayer, 1978). The growing awareness of a separate body of information required for clinical success with elderly patients, combined with the increasing number of older Americans, demand new approaches to health care of American elders when the old approaches are shown to be unsuccessful. Current patterns of health care delivery to elderly Americans are discussed and found to be inadequate; and possible new initiatives allowing early detection of disability and prevention or retardation of decline through surveillance of high risk elderly and education are presented.

In examining the problems and patterns of service utilization of the elderly it becomes apparent that "the elderly" are heterogenous, and considering all Americans over 65 years of age as a single group requiring and consuming the same health services leads to an unfocused and therefore unproductive view of aging. This heterogeneity of older Americans has spawned the curious but practical distinction between the "young-old" (those 65-74 years of age) and the "old-old" (those over 75 years of age), to identify the substantially greater need for

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*Geriatric medicine is the unique body of knowledge concerning disease in elderly individuals. Gerontology is the body of knoweldge concerning biomedical, social, and behavioral changes associated with normal aging. Together they comprise geriatrics.

service, prevalence of disability, and risk of abrupt decline and institutionalization among the older segment of post-retirement Americans. The concept of risk is crucial in discussing better health services for elderly Americans, and one definition of high risk is heavy health service consumption, including long-term institutional care. Although only 5 percent of older Americans live in long-term care institutions at any one time, for each aged nursing home resident there are at least two home-dwelling elderly who qualify for institutional care (General Accounting Office, U.S., 1979). The impaired elderly living at home differ from the nursing home group primarily in having a capable family network providing the informal supports which allow continued community-dwelling. The most impaired, high service-consuming elderly comprise 15 to 20 percent of the population over 65 years old and are at highest risk for health related decline.

For the 95 percent of Americans over 65 years old living in their own homes, the risks for institutionalization, cognitive loss, physical decline, or death are frightening daily realities; and the risk of each increases with age. With only 5 percent of over 65 year old Americans in nursing homes, it would apparently be reasonable to regard the nursing home experience as largely irrelevant to American elderly in spite of the high cost; but individuals currently 65 years of age and older have a 20 percent chance of being admitted to a nursing home in their remaining life time. People over age 80 are much more likely to die in nursing homes than in their own homes. The cost of nursing home care has become a major component of American health care expenditures. Since 1972, there have been more long-term care institutional beds in America than acute hospital beds. In 1976, nursing home care cost 10 billion dollars, rising to 16 billion dollars in 1979. The 1980 cost is projected at 21.6 billion dollars; and in 1990, nursing home costs are expected to reach 70 billion dollars (Butler, 1980).

Long-term institutional costs are only a part of the massive bill for health care of our aged population. Though only 11 percent of Americans, elderly individuals account for 40 percent of the annual acute hospital bed days, buy nearly 30 percent of the prescription drugs, and overall generate nearly one-third of American health costs. This is not to say that use of health resources by older persons out of proportion to their population representation is wrong or unfair. The prevalence of disease and disability rises sharply with age; and is highest in the very segment of the elderly population increasing most rapidly of all, the old-old. Americans 85 years of age and older have increased 40 percent in the past decade, and are expected to increase another 85 percent by the turn of the 21st century. But small gains in health care delivery efficiency in the highest service-consuming group would translate into large gains in life quality and perhaps cost saving as well. Thus careful examination of health care service provision for and utilization by the elderly is sensible. Efforts likely to ameliorate or prevent the illnesses producing the disabilities and dependency which require institutional or substantial community care for frail elders would be a major asset to our health care system.

For the 1.1 million older Americans already living in institutions (largely nursing homes), the risks of concern are the same as those for community dwelling elderly, obviously excluding institutionalization. Cognitive loss, physical decline, and even death are common consequences of unattended disease in old people. As disease progresses undetected in elders, prolonged disability and permanent functional losses become increasingly likely. Since illness and loss are, at least statistically, predictable, identification of high-risk elderly and periodic checking for decline is a sensible approach to improving care of older Americans. As informal support networks in communities become less available to provide home delivered services for dependent elderly (because nuclear families are replacing extended ones, and care-giving daughters and daughters-in-law are entering the work force), the demand for expensive, formal community and institutional services will continue to rise. Early detection of illness and prevention of disability in older people will therefore likely save money on total service consumption and improve life quality by maximizing independence. It is likely that an early detection program will result in higher aggregate costs early on because of the increased demand generated by case finding and referrals. However, in the long run, overall costs should be lower because of early, less costly interventions which will avoid or delay costlier interventions and long-term institutionalization.

The epidemiology of geriatric health care delivery problems has not yet been clearly defined. But likely valid cross-cultural inferences can be drawn from European studies showing that elderly individuals tend to have multiple illnesses which detrimentally interact with one another; and that symptomatic disease-burdened old people do not present themselves promptly for medical care (Anderson, 1966; Williamson, 1964). The impact of late detection of multiple far-advanced diseases in elderly patients is predictably bleak, producing long, expensive hospitalizations yielding poor functional recovery and prolonged disability often requiring temporary or permanent nursing home care. Passive reactive care is the antiquated model of health service delivery continuing today, neglecting disease prevention and life style alteration which seem to be essential elements of declining mortality figures in America (Fries, 1980).

As medical technology capable of preserving previously irretrievable lives becomes more potent, late intervention in elderly patients will have increasingly expensive and discouraging outcomes. The goal of efforts to improve health care delivery for older Americans is to redirect health service provision to be more active in case finding and thus prevent expensive and discouraging dependency needs in high-risk, frail, elderly individuals.

Strategies avoiding delay in evaluation and treatment of illnesses which underlie functional disabilities in the elderly ameliorate existing clinical problems and prevent future ones. In fact, the system is both the solution and the prevention. Surveillance of high risk elderly individuals must be built into their health care system to detect and assess functional impairment and prevent further disability which, if unattended, can become permanent in spite of eventual proper treatment. Identification of high-risk elderly who need and would benefit most from surveillance is relatively simple. By definition, the nursing home dwellers are frail and at high risk. Their surveillance would appear to be automatic by virtue of their omnipresent caretakers; but some data suggest that this may not necessarily be so, and additional safeguards may be needed to ensure prompt assessment of new disability (U.S. Dept.of HEW, 1977). In the community, high-risk elderly are a small subset, but have some easily recognized indicators of risk; including age, illness, and environment. Once identified, at risk elderly individuals would be assessed at home periodically; and any functional decline, reported or observed, would provoke more formal comprehensive medical assessment by the responsible facet of the health care system.

In addition to surveillance of the vulnerable aged population in and out of nursing homes, a second component of the solution/prevention mechanism which must be developed is education. General and specific data about gerontology and geriatric medicine must be widely taught to caregivers in the multiple disciplines likely to encounter or refer vulnerable elders in distress. Academic programs in geriatrics are currently under development in many universities and in numerous disciplines. Leadership at several centers has been undertaken by medicine, in spite of its reputation among the psycho-social long-term care professions for neglect of frail elders, especially in nursing homes (Institute of Medicine, 1978). It is ultimately within medicine that responsibility lies for education which will facilitate the goals of surveillance - early diagnosis and prevention of dependency.

Risks

The frail elderly are those at highest risk for decline based on health-related problems. Careful surveillance of their condition is crucial to detecting early decline based on illness and preventing functional losses which reduce life quality and increase cost. The community-dwelling, high-risk elderly are identifiable by several markers (Palmore, 1976). Those over 75 years of age are 3 to 5 times more likely to require assistance due to health impairment compared with 65 to 74 year olds, making advanced age a first reasonable marker. Elderly persons living alone are at greater risk, if only because decline is less likely to be noticed. Persons recently bereaved are at greatly increased risk to become ill and even die in the grieving period and post-bereavement year. Elderly individuals recently discharged from hospitals have a 1 in 4 chance of rehospitalization in the following year, marking increased risk. Others who would appear to have increased risk but for whom the risk has not been documented include aged persons with cognitive loss, mobility problems, or incontinence.

High Risk Community Elderly (Table 1)

1. Over 75 years of age.
2. Living alone.
3. Recently bereaved.
4. Recently hospitalized.
5. Incontinent, immobile, or demented.

The most frail elderly Americans generally reside in nursing homes, where round-the-clock "surveillance" already exists. Unfortunately, high quality surveillance in most long term care facilities is sadly lacking for a variety of reasons. Most nursing homes are understaffed, particularly with well trained professionals who are best qualified to assess and monitor health status and function of patients. Physicians, when they appear in the facility, tend to be acute illness, crisis-oriented and are likely to see only those patients identified as "having a problem." Registered nurses have become so administratively burdened that their patient contact is primarily limited to that care which, by law, only they can provide. They therefore are unlikely to monitor patient function in a systematic way, and may only become aware of decline if it is called to their attention by aides or other staff. Finally, the nursing home, both by its structure and in societal attitudes toward it, presents multiple incentives to dependency. Decline in independent function may be viewed by family and staff as a "natural adjustment" to the nursing home setting. New initiatives are needed in nursing homes to alert staff to a surveillance role and to prevent unrecognized decline.

A pervasive phenomenon partly responsible for advanced disease states engendering major disability in frail elderly is the failure of the elderly themselves to report illness. Legitimate symptoms heralding serious but often treatable disease are concealed, or at least not reported, by elderly patients.

The first suggestion that older persons did not seek medical attention when suffering health-related functional decline came from Scotland. In the 1950's and 1960's, several pioneer geriatricians screened elderly individuals, seeking information about illness behavior; suspecting that verifiable differences might underlie the clinical impression that old people did not seek medical care promptly when ill (Anderson, 1966; Williamson, 1964). The findings in these and subsequent verifying studies were surprising, even to the investigators. A figurative iceberg of concealed disease was discovered among Scottish elderly enrolled in the British National Health Service which appeared to have the necessary features to provide adequate service to the elderly; i.e., doctors responsible for each older person's outpatient care, free care, and numerous accessable doctors' offices. Yet startling numbers of problems were discovered hitherto unknown to and untreated by the patient's responsible physician. Nor were the problems esoteric, requiring sophisticated diagnostic methodology. Frequently encountered disorders included congestive heart failure, correctable hearing and vision deficits, tuberculosis, urinary dysfunction, anemia, chronic bronchitis, claudication, cancers, nutritional deficiencies, uncontrolled diabetes, foot disease hampering mobility, dental disease impeding nutrition, dementia, and depression.

Further questioning of subjects and review of primary data led to some clear explanations for this apparently self-destructive illness behavior of elderly Scots. The most common explanation for symptom tolerance and non-reporting was the pervasive belief that old age is inextricably associated with illness, functional decline, and feeling sick. Old and young, lay and professional, men and women, all believed that to be old is to be ill. Obviously this ageist view of health and disease guarantees that older individuals, even when afflicted with the same symptoms which impel the middle aged sick into the mainstream of the health care system, will not seek care, will suffer in silence the progression of many diseases, and endure the functional losses engendered by untreated illness. That old age in the absence of disease is a time of good health and persisting function has been documented by numerous studies of normal aging (Finch, 1977); but while our society labors in ignorance of gerontologic information, elders will continue expecting decline and dysfunction. A cliché in geriatrics worth remembering is that sick old people are sick because they are sick, not because they are old. Though certainly numerous physiologic declines characterize normal human aging, these declines are gradual, and their functional impact is ameliorated by the decades over which they occur and by the remaining, if diminishing, reserve capacities of the individual. Thus major functional decline, especially if abrupt in an individual already old, is usually attributable to disease, not aging.

A second explanation for old people not reporting illness was that the high prevalence of depression, coupled with the many losses common in late life, interfered with the desire to regain vigor. A third block to reporting illness was found to be intellectual loss. Though never normal, the increasing prevalence of cognitive loss with age is doubly dangerous to the detection of disease. Cognitively impaired individuals have a diminished ability to complain and are also evaluated less enthusiastically for associated medical disease or even reversible disease producing the intellectual losses themselves (NIA Task Force, 1980). A fourth explanation for symptom concealment by elderly patients was the fear that something would be found and generate diagnositic or therapeutic interventions which in themselves will produce functional loss and jeopardize independent living. Finally, today's octogenarians, having grown up when health care systems produced less salubrious interventions, may be reluctant to seek care even in the present.

The abundant documentation of disease non-reporting by the elderly appears to contradict a clinical rule-of-thumb identifying hypochondriasis as common among aged patients. Many clinicians caring for elderly patients cite an individual or two who tries their patience and goodwill with endless complaints rooted in trivial or nonexistent illness. Yet when studied, the hypochondriacal, doctor-shopping, old person appears to be one more unverifiable mythical figure in aging (Costa, 1980). Not only is hypochondriasis less common among older people, but when elders do complain, important disease is found underlying their complaints substantially more often than in younger, non-hypochondriacal individuals (Stenback, 1978).

Non-reporting of symptoms reflecting underlying disease in elderly persons is an especially dangerous phenomenon when coupled with the American organizational structure of health care delivery. Our health care system is passive, especially for elderly people; and lacks prevention-oriented or early detection efforts. American medical care of the critically ill elderly hospitalized patient is the best in the world. Science and technology are most expertly blended to help the sick. But American hospital beds, HMO's, physician offices, emergency rooms, and neighborhood health centers all wait passively for the symptomatic patient to activate the system. For the most part, this passive system of health care provision is adequate for children, who have parental advocates; and young and middle-aged adults who have the need to work and earn impelling them to seek medical relief of function-impairing symptoms. But aged persons, without advocates and usually without jobs, burdened by society's and their own ageist views of functional loss in the elderly, cannot be relied upon to initiate appropriate health care for themselves; especially early in the course of an illness when intervention is most likely to have a favorable outcome. Our health care system relies on the patient to enter the system and initiate care; and that is precisely the one illness behavior most reliably documented to be missing in aged individuals. The failure of illness reporting by the elderly, coupled with passivity of our heatlh care system, make undiagnosed decline especially likely and suggest that adding a more active facet to the system for the elderly would be beneficial.

A second risk for older Americans in our health care system was again identified in Scotland. A year long study of 4,000 hospital deaths in individuals over 65 years of age revealed a recurring pattern of preadmission debility and surprisingly long stays in those patients destined to die (Isaacs, 1971). The older patients were, the longer they survived before dying in the hospital. A high proportion - nearly three-quarters - of the deaths were preceded by a period of increasing dependency prior to hospitalization. A high correlation of dependency with advancing age and death following hospitalization led to naming the dependent period "pre-death." The commonest causes of the pre-death dependency were immobility, incontinence, and mental impairment, often in combination. The durations of pre-death and attendant hospitalization were strikingly age-related, as was the likelihood of hospital death. Although deaths of the very old occurred more often in geriatric or psychiatric beds (in which average hospital stays were substantially longer than in acute American beds) than in acute medical or surgical beds, it was astonishing to find that the average hospital stay before death was 3 months for patients 65-74 years of age; 6 months for those 75-84 years of age; 7 months for men 85 years and older; and 13 months for women over 85 years old. Retrospective analysis of a small subject sample revealed a high proportion with potentially reversible or at least improvable causes for the pre-death dependency, had appropriate evaluation and treatment been undertaken early. Once again it appears that long, costly, discouraging dependency among old people might be avoided by a more active case-finding component of the health care system.

A third factor predisposing elderly individuals to functional decline based on late detection of potentially treatable disease is the common occurrence of illness-clustering in aged patients. Usually termed multiple pathology, the existence of several concurrent diseases in an old person who either is not obviously ill or is under treatment for a separate problem has a profound negative influence on health and functional independence in old age. Williamson's random sample of community-dwelling subjects over 65 years of age found nearly 3.5 important disabilities per person (Williamson, 1964). An earlier study of elderly patients being admitted to hospitals documented 6 pathological conditions per person (Wilson, 1962). A recent American clinical experience tabulated common problems often co-existing in elderly individuals (Besdine, 1980).

1. Congestive heart failure
2. Depression
3. Dementia syndrome
4. Chronic renal failure
5. Angina pectoris
6. Osteoarthritis/osteoporosis
7. Gait disorder
8. Urinary difficulty
9. Constipation
10. Arterial or venous insufficiency in the legs
11. Diabetes mellitus
12. Chronic pain
13. Sleep disturbance
14. Multiple drug regimens
15. Anemia

When 6 or more of these problems co-exist in one elderly person, and they are not known to the physician treating the one currently active disorder, difficulties are likely to arise. When the entire spectrum of multiple pathologic conditions is not identified and carefully considered, virtually any diagnostic or therapeutic initiative undertaken is as likely to produce harm as benefit. In the absence of obvious flare of one of the problems, major danger still exists for the patient with multiple pathology. Korenchevsky first pointed out the destructive insidious virulence of unattended multiple pathologies in the uncomplaining elderly patient (Korenchevsky, 1961). The undetected, untreated diseases create ricochetting stress in several organ systems or tissues, producing deterioration of a previously diseased, but compensated physiologic function. As each over-burdened organ fails, there is created "what rapidly becomes an irreversible concatenation of deteriorations, passing multiple points of no return, leading to infirmity, dependence, and if uninterrupted, death" (Besdine, 1980). The retrospective identification of previously unidentified disorders having produced irretrievable functional losses in a once independent elder is a truly depressing aspect of geriatrics. Awareness of the frequency and hazards of multiple pathology in the elderly must be coupled with activism in our health care system to detect problems and intervene early in individuals likely to have multiple disorders.

Thus far risks have been identified which are specific to elderly patients and interact with the passive quality of our health care system to jeopardize independence in older individuals because of late detection and ineffective intervention. Another kind of risk predisposing elderly persons to functional decline based on inadequately managed health problems is the danger resulting from inadequate education of their health care providers. Danger to elderly persons from health professionals ignorant of the data base of geriatrics is especially frightening; since the presence of goodwill, hard work, and genuine caring for elderly individuals does not protect them from hazards arising from lack of knowledge. The relevant data base has been summarized recently (Besdine, 1980), and is available in substantial detail (Brockelhurst, 1978; Rossman, 1979); but as long as the geriatric data base is not actively taught in the mainstream of health professional education, elderly persons have no assurance of benefit from the existence of the information, however extensive or complete.

The data base required for successful care of the elderly has numerous components, and the following list is intended only to suggest the scope of information available:

1. Unique bio-behavioral changes due to normal human aging which make a healthy old person different from a healthy young one.
2. Special diseases generally encountered only in aged patients.
3. Altered presentation and clinical behavior of many diseases stemming from the impact of age-related changes.
4. Unusual complications and unexpected outcome of illness (including surprising survival and recovery).
5. Unique features of psycho-biology and psychiatric illness in the elderly.
6. The common occurrence of multiple pathologic conditions among elderly individuals.
7. A need for different usage of therapeutic drugs based on unique pharmacokinetics and pharmacodynamics in the elderly.

When demographic, psycho-social, and economic data specific to the elderly are added to the large biomedical outline above, a major educational initiative emerges as necessary to ensure competent clinical care of ill older persons. Arguments have been made for a specialty of geriatrics to guarantee that the requisite data base be adequately taught. Optimum strategy for ensuring teaching of the data base to complement surveillance of high-risk geriatric patients is discussed.

Solutions: Education

Responsibility for competent clinical care of the aged sick has consistently resided within the mainstream of the medical care community in America. All practitioners, unless specialty-restricted, are expected to offer the same attentiveness, concern, dedication, and expertise to elderly patients under their care as they do to younger ones. Certainly a large amount of American practitioner time is already spent caring for elderly patients; and a large proportion of American health resources is expended on older individuals with substantial practitioner income deriving from their care (Institute of Medicine, 1977). Yet there is accumulating opinion that the practice status quo is inadequate to meet the health care needs of the growing aged American population (Institute of Medicine, 1978). Much has been written and argued recently concerning the establishment of a new age-related American clinical specialty exclusively concerned with the elderly (Kane, et al., 1980). Older patients in general seem to receive less careful and enthusiastic care from a variety of practitioners; and the physically or intellectually disabled elderly are an especially neglected subset. Thus, the first reason to justify geriatrics as a specialty is medical neglect of elderly patients.

Long-term care is the therapeutic essence of geriatrics and of much contemporary medicine, with professional success and gratification deriving from restoring and preserving maximum function and improving life in the face of chronic or recurrent disease; contrasted with the widespread myth that cure is the only goal of modern medical intervention. Long-term care is, of course, caring for people over a long term in a variety of settings; but usage has equated long-term care with institutional care, largely for old people in nursing homes. There are strong disincentives for physicians to visit patients in nursing homes; and it is not surprising that physicians tend to visit nursing home residents infrequently and to see many at once, giving little time to each individual. A second reason for a specialty of geriatrics is to ensure adequate long-term community-based and nursing home medical care.

Examination of successful long-term health care delivery to elderly persons identifies the ubiquitous need for multiple professional disciplines participating conjointly in clinical evaluation and treatment planning. Truly interdisciplinary care, in which the requisite team members know each other's capabilities and function together, is not currently taught to physicians; and therefore, patients who most need interdisciplinary team care are most often denied it in current therapeutics. Thus, the third reason for considering a specialty of geriatics is to guarantee interdisciplinary team participation in geriatric care.

Although not as developed or advanced as the data base in other age or disease-categorical specialties in medicine, the fund of knowledge available in geriatrics is substantial. Data documenting normal age-related changes are accumulating rapidly as competent studies in gerontology proliferate (Finch, 1977). The disease-specific information allowing excellent care of elderly patients is also expanding and being disseminated through age-specific publications and increased attention to aging in the general medical literature. A fourth reason to develop a specialty is the enlarging relevant data base which must be mastered for high-quality clinical care of elderly patients.

Documentation and dissemination of the geriatric data base in medicine, coupled with increasing public awareness of needs and numbers of frail elderly

Americans and their previous neglect, has produced a sharp rise in demand for geriatric content in medical education. Many American medical schools seek academic leadership in geriatrics, only to find that qualified teachers and investigators are in even shorter supply than clinicians knowledgeable in care of the elderly. The fifth reason for a specialty is the need to develop teachers and curriculum in aging for American medical schools.

Academic and clinical deficiencies related to geriatrics can be met in one of two ways. A new clinical specialty of geriatrics would guarantee practitioners who would attend to the health care of the aged population, but several negative aspects of such a venture emerge. Historically, geriatrics in America has had a reputation for attracting practitioners who were less vigorous than average. This substantial liability would be difficult to overcome in clinical programs seeking to identify and recruit practitioners willing to limit their work to the elderly. Another major problem created by a clinical specialty would be the inevitable isolation of care of the elderly and its knowledge base from the mainstream of medical education and practice. Splitting off care of the elderly potentially implies an entire additional geriatric care structure, facing the challenge of creating and maintaining seperate but equal clinical facilities and personnel; a task that, at least in public education, the Supreme Court found insurmountable.

An alternative solution to the deficiencies in care of aging Americans allows continued integration of gerontological and geriatric medical information into the mainstream of education and practice. An academic specialty of geriatrics demands a relatively small number of medical educators and investigators exclusively committed to acquiring, expanding, and transmitting the data base of geriatrics. Geriatric units or divisions in medical schools and teaching hospitals would provide basic science and clinical geriatric education for medical students, house staff, and current practitioners in the mainstream of medicine. Additionally, the identification of long-term care facilities to serve as "teaching nursing homes," much along the model of teaching hospitals, is a necessary step in improving medical education and physician attitudes toward the institutionalized elderly. All future practitioners would have training and experiences counteracting the ageist bias in our society and within medicine itself. These geriatric units in medical schools, hospitals, and nursing homes would be led by physicians fully qualified to compete for faculty positions and advancement in the academic mainstream of American medicine. An additional responsibility of academic geriatric units would be the continuing training and graduation of the relatively small number of academic geriatricians required to populate and replenish the units themselves. A few of the existing academic geriatric units have begun to produce new academic geriatricians via publicly and privately funded geriatric fellowships providing clinical, didactic, and research post-residency training in geriatrics. In the authors' view, this latter solution of an academic specialty of geriatrics responsible for introducing the geriatric data base into the mainstream of health provider education meets a majority of the identified needs and avoids most potential pitfalls associated with geriatric education.

Solutions: Surveillance

When the full spectrum of risk for unnoticed deterioration of elderly individuals is arrayed beside the passivity of our health care system, the picture seems discouraging. Frail elders, representing 20 percent of the post-retirement population, are likely to have multiple pathologic conditions whose symptoms are not reported. Diseases progress, one failing organ system stressing another producing functional declines that become irreversable, requiring more supportive care including nursing home admission; and eventually, if unattended, produce pre-death with its attendant prolonged hospitalizations. At each turn in the downward spiral of functional loss, more costs are engendered and life quality is eroded. How can intervention avoid the depressing declines described? Changing the biology or psychology of the elderly themselves, or altering societal beliefs, seem herculean tasks. But a minor addition to the health care system as it functions for the elderly may be relatively simple, inexpensive, and effective.

Active assessment and continuing surveillance are central to high quality life and services for the elderly at risk. This assessment should address not only the physical health of the individual, but also the quality of self-maintenance, intellectual status, social activity, and emotional health (Lawton, 1971). Changes in any of these indicators should trigger a systematic search for the underlying causes to generate thoughtful treatment, compensation, and/or rehabilitation.

The responsibility for assessment and surveillance rests with a variety of persons, programs, and institutions. The first and generally most important individuals are elderly persons themselves. Barring serious cognitive losses, they are the first to notice pain or other distressing symptoms, to experience difficulty in personal care or the maintenance of their homes, or to discover changes in their interpersonal relationships. They must be helped to recognize these changes as potential indicators of illnesses, and encouraged to seek formal assessment and treatment.

Families, friends, and neighbors form the informal support network. It is estimated that as much as 80 percent of long-term care services are provided by informal helpers. Lebowitz (1978) points out that successful problem solvers among the elderly obtain help first from informal sources, followed as needed by additional aid from more formal organizations and agencies. The very nature of the informal network, with its frequent regular contact over time, provides the opportunity for regular assessment and surveillance. Unfortunately, family and other informal helpers are strongly influenced by societal attitudes, and may not interpret recognized changes in functional abilities as anything but "old age." Community education aimed at the elderly and their informal caregivers should describe "danger signals" of potential illness, and indicate appropriate community resources to address these problems.

Formal providers also have a surveillance opportunity which is often missed. One would assume that clients at home with regular professional contacts, or patients in institutions, would automatically be assessed and monitored. Unfortunately, either because of narrow service definitions, or lack of staff awareness, substantial changes in functional ability go unnoticed and therefore untreated until they reach advanced stages of severity making intervention costly and of limited success.

The optimum system for assessment and surveillance would involve the older person, family, other informal helpers, service providers, and a specially trained surveillance technician. The role of the technician would vary, depending on the surveillance resources and opportunities available. For those elderly with an active informal network or regular contact with formal service providers, the technicians would simply assure that the various participants recognize the need for surveillance, and would occasionally check to see that no major changes in functional status or monitoring personnel had taken place. For those elderly with weaker informal supports or infrequent professional contact, a regular surveillance schedule would be established, the timing of visits depending upon the level of risk.

Assessment should address the needs of the total individual, taking into
nsideration the complex interactions among "physical, social, and psycho-
gical functioning" (Sherwood, 1977); and recognizing that ill health not
ly affects social and economic well being, but is in turn exacerbated by
se same factors. Each local catchment area's elderly population is likely
vary in its requirements for surveillance. Number and type of health pro-
ers, identifiable at-risk elderly, population density, geographical size,
any other factors will influence the details of the surveillance apparatus.
n the absence of reliable informal caregivers, periodic formal surveillance
e required for high-risk elderly. These most vulnerable individuals
e 1) can be located by census data, Medicare rolls, hospital and physician
s, and by community communication networks available to caregivers already
ce. Surveillance technicians need only receive a short orientation course,
g them to collect invaluable information about the condition of at-risk
y. In less than three months a mixture of geriatric data base, details
rea's health care structure, strategies for successful interaction with
ents, and surveillance techniques themselves could be provided for
trainees. The frequency of surveillance visits would be determined
lnerability and instability of the old person, but most individuals
seen no more than five times each month, and most much less often.
ls so unstable that they require more than weekly visits will likely
l supports inserted to prevent the decline that the surveillance
ds so probable.

urveillance process itself will have two major components, consisting
tion by the technician and a questionnaire for the client. Observa-
collected will be both environmental and personal. Circumstances such
perature, dangerous furniture or rug placement, refrigerator and pantry
ating and cooking hazards, laundry, odors of incontinence, and other

signs of risk or evidence of decline in self-care will all be noted. Identified problems will be addressed and solutions attempted promptly, with appropriate referral and followup. The client will be discreetly observed for general vigor, gait, level of activity, cleanliness, signs of incontinence or injury, emotional state, and any other evidence of decline or change. A simple questionnaire will also be administered, asking about biological problems like mobility, excretion, breathing, diet, pain, memory, feelings; and about environmental, social, or economic problems; reliability of formal or informal caregivers, safety; and any other potential hazards. After an initial assessment session, followup visits would be brief and largely social unless new problems were identified, which would then initiate the proper remedial service following consultation between the technician and backup personnel. The initial assessment profile and any subsequent changes would be logged onto a summary surveillance record for each client and made available to the health providers responsible for care. Gaps in the continuum of care available in the community would be filled and reinforced to ensure that the needs identified by surveillance would be adequately met.

The most efficient and humane use of limited resources is early intervention with the most appropriate services (Wetle, 1977). Such a person-centered approach is possible only when the client's condition is carefully and regularly assessed and monitored. Only then will the continuum of care truly meet the needs of older persons.

Research

Several research gaps emerge from discussion of surveillance for high-risk elderly as a preventive strategy in the declines seen commonly in community dwelling individuals. First, epidemiologic studies would be useful in verifying the British and Continental European samples documenting multiple pathology and nonreporting of illness in the elderly. Suggestive American data already exist, and U.S. gerontologists and geriatricians agree generally that their own observations confirm the earlier findings (Besdine, 1980). Though it would be reassuring to recapitulate the European studies before we embark on active surveillance programs predicated on health and illness behavior not yet verified in American elderly, we run the risk of reinventing the wheel while the carts accumulate on the assembly line. Enough data currently are available to urge an initiation of surveillance in sample settings simultaneous with establishing epidemiologic studies of illness patterns and behavior in American elderly.

The second research mandate within the surveillance proposal is far more urgent than the epidemiologic one. As pilot surveillance projects are established in communities with many high-risk elderly individuals and the staggering service burdens that these clients generate, careful sophisticated research methodology must be assembled concurrently so that we will know exactly what facets of surveillance are most effective and how the process works overall. Study design will not be simple, and ethical as well as methodological problems will arise. Establishing control groups in an ethical fashion is a first task for the investigators studying surveillance outcome. In spite of complexities and impediments, surveillance programs must be implemented and evaluated if we are to reduce the dependency burden and all its attendant distress in high-risk American elderly.

RECOMMENDATIONS

A. Service

1. Identification and remedy of current deficiencies in the continuum of care required by elderly individuals for successful community-dwelling must be accomplished.
2. Aged individuals at high risk for decline based on health problems must be identified in the community and systematically included in a surveillance program to detect decline early and prevent its progression when possible.
3. Responsibility for surveillance by catchment areas should be assigned to programs providing services to community elderly, and costs should be reimbursable under Medicare/Medicaid.
4. Surveillance should be done by specifically trained low technology individuals, such as nurse aides, homemakers, day care workers, etc. (surveillance technicians).
5. Surveillance technicians would monitor high-risk elderly individuals by home visiting, using observation, a simple questionnaire, and a checklist; and persons with new problems or decline would be referred for further evaluation.

B. Education

1. Elderly individuals, their families, and other informal care givers should be the target of a public education campaign emphasizing that disability in old age is usually due to disease, not "old age"; and symptoms should be reported and evaluated.
2. Appropriate aspects of the geriatric data base should be included in educational programs for health and social service providers in all disciplines serving the elderly.
3. Geriatric medical education should be provided by academic geriatricians in the mainstream of the educational process. Geriatrics should not become a separate clinical practice specialty in America.
4. Health professional schools should identify selected nursing homes in which educational programs can be developed to effectively teach care of the elderly.

C. Research

1. Undertake epidemiologic study of elderly Americans at home to verify that they, like their European counterparts, do not report symptoms and functional losses marking important potentially treatable diseases;and to refine the risk factors which predict potential decline and illness.
2. Undertake careful study and documentation of the impact of a surveillance system for high-risk elderly.

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"WHITE PAPER" ON SLEEP AND AGING
FOR 1981 WHITE HOUSE CONFERENCE

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I. PREFACE

An institutional concern about problems of sleep and wakefulness in the elderly has several precedents. In June 1978, the National Institute on Aging (NIA) sponsored a Research Planning Workshop on Sleep and Aging; a summary of the workshop's findings and recommendations was subsequently published (194). NIA also commissioned a monograph containing a comprehensive review of the pertinent literature on sleep and aging for distribution to workshop participants. This monograph was subsequently updated and published (184).

The present paper relies heavily on the above review. In keeping with the needs of the White House Conference on Aging, however, we focus more on the areas of sleep and aging that seem most important for the well-being of our older citizens and where future research seems most likely to make a difference. We have discarded areas that seem either less important or more peripheral and are likely to be considered by other writers. Certain material has been relegated to an appendix.

In view of the increasingly large number of older persons in our society and their ubiquitous concern about sleep, the most salient feature of sleep and aging is the paucity of data and the overall neglect of its key problems. Only one classical sleep research area- normative description of nocturnal sleep parameters- has been extensively investigated with respect to age. Several very important areas of sleep research have no citations whatever that pertain to the aging process.

Changes in sleep appear to be a very consistent sign of biological aging. For many years, the sleep of the elderly has been observed to be different from that of younger people. As with other age-related changes, it has not always been obvious whether these findings are signs of "maturation" or signs of sleep pathology; and we have yet to determine the extent to which our recently acquired knowledge about sleep pathology in young and middle-aged adults can be directly applied to the elderly.

In addition to a panoply of "natural" and pathological changes in sleep/wake function, we must keep in mind that the elderly face many other problems including failing health, financial restrictions, retirement, increasing bed rest, lack of physical exercise, postmenopausal changes, use of medications, loss of family and friends, social isolation, and poorly appreciated sexual problems, all of which can directly or indirectly affect the quality of sleep/wake functions.

In this "white paper" on sleep and aging, we highlight current information on sleep and aging with extensive citations from the literature for those readers who wish to delve further. Of more general interest is the final section, in which we will summarize the most important aspects of these consideration, point out the most serious gaps, and make urgent recommendations for the immediate future of the field.

II. COMPLAINTS AND THEIR MEANING- SUBJECTIVE AND OBJECTIVE SLEEP PARAMETERS- IN ELDERLY MEN AND WOMEN

A. QUESTIONNAIRE STUDIES

A number of studies have specifically surveyed sleep in the elderly (13, 97, 131, 164, 200, 252, 253, 254, 259, 281). Other studies have compared subjective sleep parameters across age (16. 17. 139, 145. 202, 261, 262, 263, 284, 299). These surveys support the view that the elderly are generally dissatisfied with their sleep. Complaints of nonspecific sleep disturbance and awakenings during the night, along with the use of sedative-hypnotic medications, all appear to increase with age. Most of these studies were carried out on relatively small and nonrepresentative samples, however, and questions were formulated very differently by different investigators.

Several surveys with larger samples deserve special mention. In Great Britain, the 1962 McGhie and Russell survey of 2466 subjects aged 15 to "over 75" years described sleep disturbance in several ways (177). In respondents over 65 years of age, there was a significant increase (to 15%) in the proportion who claimed to sleep fewer than 5 hours each night. Complaints of prolonged sleep latency were found to be approximately twice as prevalent in females in all age groups; furthermore, these complaints were reported significantly more often in females over 55 years than in younger women. Elderly subjects of both sexes also reported "frequent night wakening" more often than younger subjects; in subjects over 65 years of age, 25- 30% reported this complaint. Early morning awakening was also reported more often in the elderly, with as many as 15% of respondents aged 65-75 reporting arousal before 5:00 a.m. Twenty-five percent of the men over 65 years and 40% of women over 45 years described themselves as "light-sleepers."

The Karacan et al. (150) study of 1645 adults (aged 16 and older) in Florida's Alachua County showed that 45% reported trouble getting to sleep or staying asleep during the night. Positive responses were said to be "higher" in females and with increasing age. For individuals who reported at least one sleep complaint: 55% had trouble falling asleep, 15% had trouble staying asleep, 6% had insufficient sleep, 3% awoke too early, and 1% had too much sleep. Ten percent of all individuals in the study reported using sleeping pills "sometimes" or more frequently. Pill taking was "higher" for females and "increased markedly" with age. A similar study was carried out in the Houston Metropolitan area by the same group (258). Thirty-three percent of the respondents reported some difficulty getting to sleep, 48% had problems with awakening during the night, and 22% had difficulty with early final awakening. Nine percent sometimes took sleeping pills. Once again, sleeping difficulties were higher in females and higher with increasing age.

In 1964, Hammond (120) reported initial data from a prospective survey of 1,057,398 subjects over the age of 30, carried out by 68,116 volunteer workers of the American Cancer Society. The complaint of insomnia tended upwards with age in both men and women reaching a plateau at about 50. Overall, women complained more (31%) than men (16%).

Recently, Kripke and his coworkers (159), including both Hammond and Garfinkel, re-examined these survey data with emphasis on sleep variables. For this report, the previous data (120) were re-analyzed along with six years of prospective follow up data. The most salient feature was the highly significant relationship between stated nocturnal sleep time and mortality. Even those men and women with no prior history of heart disease, high blood pressure, diabetes or stroke, were more likely to die within six years if they reported that they usually slept more or less than 7-7.9 hours. These increased deaths were not associated with a reported complaint of insomnia, nor with sleeping pill use. Nevertheless, males and females who "often" took sleeping pills died 1.5 times as frequently as matched subjects who never used sleeping pills, and this appeared true for the elderly. Short sleep, insomnia and sleeping pill use increased with age.

B. SLEEP PARAMETERS DERIVED FROM ALL-NIGHT POLYGRAPHIC RECORDINGS

1. Introduction

The one area of sleep and aging that has been investigated with satisfactory intensity involves sleep laboratory studies utilizing electroencephalogram (EEG), electromyogram (EMG), and electro-oculogram (EOG) to derive a number of objective sleep parameters according to the widely used manual of Rechtschaffen and Kales (218). By and large, with the sole exception of nocturnal penile tumescence (NPT), other sleep-related physiological variables in the elderly have not been systematically investigated.

Not only has the EEG been used as one of the bases for sleep staging, but subtle age-related changes in the EEG waveform have been studied in great detail in both wakefulness and sleep. Since the Rechtschaffen-Kales sleep staging criteria are not adjusted for age, reports of sleep stages in the elderly must be interpreted in the light of specific EEG waveform changes. A number of studies of both the waking and sleeping clinical electroencephalogram are summarized in the Appendix. With EEG waveforms as with overall sleep parameters, investigators have invariably been preoccupied by the uncertainty as to whether any observed changes are due to normal "maturation" or pathology ("deterioration").

By following the instructions in the Rechtschaffen and Kales manual (218), each epoch (usually 20 sec, 30 sec, or 1 min) of the polysomnographic recording is scored as stage 1, 2, 3 or 4, REM sleep, or wakefulness. Using these scores, "classic" sleep stage parameters are derived. These include Total Sleep Time (TST), Total Sleep Period Time (SPT), Sleep Latency (SL), Wake After Sleep Onset (WASO), Wake After Final Arousal (WAFA), Total stage 1 (TS1), Total stage 2 (TS2), Total stage 3 (TS3), Total stage 4 (TS4), Total stage REM (TREM), Total NREM sleep (TNREM), etc. These parameters are usually expressed as durations (minutes), but are sometimes expressed as percentages of the total sleep time or sleep period time. Other parameters such as the number of wakes, or number of REM periods, are simple integers.

Despite efforts at standardization, sleep staging information is not always directly comparable in different publications. Not everybody agrees as to the polysomnographic definition of sleep onset. Some of the secondary sleep paramèters have been defined in more than one way. The total dark time (TDT) and time in bed (TIB), which may influence other parameters, are often established by the investigator rather than by the subject.

Most studies found great individual variability in objective sleep parameters; thus statistically significant trends have rarely been demonstrated. This variance stems in part from systematic changes in sleep parameters as the subjects become acclimatized to the recording procedures and environment, as well as from the small numbers of subjects in each age group. The definitions of the various stages of polygraphic sleep still rely upon age-dependent parameters, yet the coding system is not age-adjusted, and the definitions themselves are largely arbitrary and sometimes controversial. Investigations reported prior to the publication of the Rechtschaffen and Kales Manual in 1968 (218), have even less unanimity in terms of sleep stage definition. In spite of these concerns, a number of attributes of the sleep of the elderly have been well established.

2. Time in Bed (TIB)

TIB refers to the nocturnal sleep period (encompassing the main sleep period of the day, lights out to morning arising). Elderly people seem to spend more time: (a) lying in bed at night without attempting to sleep; (b) in bed at night unsuccessfully trying to sleep; and (c) in bed resting or napping during the day (81, 215, 293). Several workers have concluded that the increased TIB of the elderly is not due to increased total sleep time (146, 147, 148, 293). Data concerning the total time the elderly spend in bed each 24 hours is found in Section C below.

3. Sleep Period Time (SPT) or Total Sleep Period (TSP)

SPT refers to time from sleep onset to the final awakening from the main sleep period of the day. The variability of this parameter is such that no significant change has been demonstated in the elderly (293). The measure differs from TIB in that prolonged sleep latency and wakefulness after the final arousal can be ignored.

4. Total Sleep Time (TST)

TST refers to SPT less time spent awake during the sleep period. Although usual WASO (see below) is excluded from TST, brief (eg. 10 second) arousals are not. Studies have found TST to be either reduced or unchanged in the elderly as compared to younger age groups (5, 81, 141, 143, 147, 215, 243, 257, 275, 283, 293). Because the elderly do tend to have increased WASO (see below), their TST is especially vulnerable to an imposed TIB. Campbell and Webb (29) investigated sleep length by allowing 50-60 year-olds to sleep as long as they could. Sleep termination in the morning was acknowledged following an awakening of more than 10 minutes. The mean sleep length was shorter and less variable than for younger adults (467 minutes versus 589 minutes). When TIB is not ad-lib, the variability of sleep time in middle-aged and elderly subjects increases significantly over that of younger subjects. Total Sleep Time throughout 24 hours does not seem to have been polygraphically measured in the elderly, but some information is found in section C below.

5. Sleep Latency (SL)

SL refers to the time from lights-out (the decision to sleep) to sleep onset. In the elderly there is considerable individual variability in SL, and while some studies have found increased SL (4, 44, 81, 124, 215, 257), other workers (293) have reported little change. In females, difficulty falling asleep has been related to both age and use of hypnotic drugs (274).

6. Wake After Sleep Onset (WASO)

WASO is probably the most important sleep parameter from the point of view of sleep disturbance. It refers to the time spent awake during SPT (from sleep onset until the final awakening). WASO can represent many relatively short arousals or several long periods of wakefulness.

Many studies have found that the aged have increased amounts of WASO (3, 13, 44, 78, 78, 80, 81, 88, 124, 141, 146, 147, 148, 182, 202, 205, 215, 274, 275, 278, 283, 293, 299). The actual number of arousals may be even greater than reported, since the standard sleep scoring system is such that it is possible for a wake episode as long as 28 seconds (spanning two 30 second epochs) to be not scored as stage wake. Although not scored by the standard procedures, very brief arousals may well be quite significant. Preliminary evidence suggests that the number of brief (10-second) wakes may closely parallel changes in daytime function (Carskadon et al. unpublished observations). Sleep disturbance reflected in nocturnal arousals without complete awakening has also been assessed by noting the frequency of shifts into stage 1 sleep or the total number of changes from any sleep stage to any other (293). Webb and Swinburne (283) were able to attribute 38% of nocturnal arousals in their observational study of sleep in the aged to physical discomfort, especially distention of the bladder and urinary urgency. Others have identified pain, restless legs, and dyspnea.

7. Sleep Efficiency (SE)

SE refers to the ratio of TST to nocturnal TIB. Comparing SE across different ages is made difficult because of individual variability and the uncertain specification of TIB. However, most studies have found SE to be reduced in the elderly (81, 146, 147, 215, 293). One group of studies allows a comparison of pre-teen children, young adults, and elderly for a constant TIB of 10 hours. The SE's were 0.97, 0.92, and 0.70 respectively.

8. Individual Sleep States and Sleep Stages

a. NREM Sleep Stages 1 and 2

The elderly appear to have an increased total duration of stage 1 sleep, and an increase in the number of shifts into stage 1 sleep (5, 91, 136, 147, 293). Both findings are considered to be indications of sleep disturbance. The amount of Stage 2 sleep is apparently little changed in the elderly although the characteristic EEG "sleep spindles" may be altered.

b. Slow Wave Sleep (SWS), NREM Sleep Stages 3 and 4

In the aged, there is an absolute and relative reduction in the time spent in Stage 4 sleep (5, 23, 124, 141, 143, 147, 215, 243, 280). In general, Stage 3 sleep tends to be nominal or even elevated in elderly females, and nominal or reduced in males (5, 44, 146, 147, 182, 199, 257, 293). These changes are apparently due to the fact that the amplitude of the EEG is noticeably reduced from that in the young adult. In the sixth decade one may find little or no Stage 4 sleep in one-fourth of the population (274).

c. Rapid Eye Movement Sleep State (REM)

In general, absolute amounts of REM fall slightly in parallel with the change in nocturnal TST; but relative amounts of REM are well maintained until extreme old age, when they do show some decline (5, 81, 140, 141, 143, 147, 215). Feinberg and others (81, 82, 215) have shown that a decline in the proportion of REM in the aged appears to follow the trend of reduced intellectual function and relate to the presence of organic brain syndrome, changes in cerebral blood flow, and alpha frequency decline. When there is a decline in the amount of REM, there is also a decrease in the physiological changes associated with REM (muscular twitches, penile tumescence, rapid irregular respiration and heart rate, and increased cerebral blood flow). Sleep spindles or true episodes of stage 2 tend to interupt and fragment REM sleep in the elderly (5, 23, 124, 141, 147, 148, 293). The REM Latency (RL, time from sleep onset to beginning of first REM period) decreases slightly throughout life in both sexes, possibly due to diminished delta-wave sleep (141, 148). Hayashi et al. (124) and others (5, 81, 141, 147, 293, 294) have found that the circadian rhythm of REM sleep in the elderly appeared to shift to the earlier part of the night, so that the distribution of REM throughout the night was unusually uniform (124).

9. Sex Differences in All-Night Polygraphic Sleep Parameters

In general, elderly men appear to have more "disturbance" in their objective sleep parameters than elderly women, but these changes appear to be part of an increasing trend of sex differences which is already apparent in young adults (141, 143, 283, 293). The most obvious differences are in SWS and WASO. These findings are in contrast to survey data which show that women have more complaints about their sleep.

D. DISTRIBUTION OF TIB, TST, AND SLEEP STAGES THROUGHOUT 24 HOURS

Webb and Swinburne (283) in their observational study of the sleeping behavior of 19 people (ages 66-96 years) reported an average TIB over the 24 hour period of 716 minutes in men and 702 minutes in women. An average of 516 minutes was spent sleeping (males 558 minutes, females 474 minutes); of this amount, an average of 92% occurred during the night. The number of daily naps averaged 1.8 (males) and 1.4 (females).

E. OTHER PHYSIOLOGICAL PARAMETERS RECORDED DURING SLEEP IN THE ELDERLY

1. Nocturnal Penile Tumescence (NPT)

Penile tumescence during sleep has been very well studied compared to most functions. It appears that there is a gradual decline with age in penile tumescence during REM sleep, even though REM sleep itself, and most other REM parameters, remain fairly constant until extreme old age.

Kahn and Fisher (142) found that an average of 45% of the REM periods in elderly men were associated with full or moderate erections; during the remaining 55%, erections were slight or absent. This REM erection frequency is less than the 80-95% reported in the young adult by Fisher et al. (34, 35). There was considerable variance in elderly subjects, and about half had REM sleep erections comparable to those reported for young adults. A study by Karacan's group (151) found a slight but consistent decline in REM-related tumescence, with a closely concomitant increase in NREM tumescence with aging from 20 through 70. In the study by Kahn and Fisher (142), the relationship between the amount of REM tumescence and the reported sexual behavior and enjoyment of the elderly subjects just failed to achieve statistical significance. The authors felt that such a relationship was obscured by: (a) denial of an actual interest in sexuality, (b) inhibition of erections by anxiety, and (c) absence of an available partner or no sexual outlet. Even though capacity persisted, it was evident that avoidance of sexual behavior was often due to psychological factors.

Although Kahn and Fisher (142) noted that anxiety appears to inhibit erections during REM sleep, patients with psychogenic impotence tend to have nearly normal NPT when compared with diabetics, patients suffering from other organic diseases, and the extreme elderly. In many cases in which the actual cause for impotence is a hidden psychic condition, the elderly patient and his physician tend to conclude that it is a normal result of the aging process and based upon irreversible organic changes.

2. Cardiovascular and Respiratory Changes

Cardiovascular disease is more prevalent with advancing age. Yet, once again, there are few data describing blood pressure, pulse-rate, cardiac arrhythmias, coronary blood flow, and so forth in the elderly during sleep. Derman et al. (68) using a noninvasive 133 Xe inhalation technique, found a smaller reduction in central nervous system blood flow during sleep in older subjects as compared to young adults. Studies on respiration during sleep in the elderly are reviewed in the section on sleep pathology in conjunction with sleep apnea syndromes because disturbed breathing during sleep is unexpectedly highly prevalent in "normal" aged subjects.

3. Other Parameters

Zepelin et al. (300) found that auditory awakening thresholds (AAT) in stage 4 sleep were significantly lower in elderly men than in young men, during the first night in the sleep laboratory. Age differences were less distinct in females. Similar changes in AAT from stage 2 and REM appeared on the second night. A variety of hormonal and metabolic changes have been reported during the sleep of the elderly, the most well known being the reduction in growth hormone secretion (193).

F. ANIMAL STUDIES OF SLEEP PARAMETERS

Although the availability of aged animals is a general problem, some data are available from animal experiments. Zolovick et al. (302) reported an increase in wake time during the inactive phase of the rest/activity cycle in aged mice. Rosenberg et al. (231) found that aged rats had more fragmented sleep and spent a significantly greater amount of time awake than young rats. Zolovick et al. (302) noted a decrease in SWS in aging mice. Zepelin et al. (301) and Rosenberg et al. (230, 231) found that old rats showed no reduction in delta wave amplitude during sleep, but they did find a decline in the amplitude of the circadian rhythm of SWS. REM sleep also appears to undergo considerable change in nonhuman mammals. Chase (45) demonstrated a substantial reduction in active (REM) sleep in aged cats, and Zolovick et al. (302) found a significant decrease in REM sleep in aged mice.

G. SUBJECTIVE COMPLAINTS ABOUT SLEEP AND THEIR MEANING

1. Insomnia— the Complaint of Disturbed Sleep

Although very large numbers of individuals complain about their sleep, very few consult sleep specialists or even physicians. Thus, it is not clear what aspects of sleep-related dysphoria are responsible for certain individuals seeking professional help. This area has been approached by comparing complaints and sleep parameters in patients.

Complaints about disturbed sleep and insomnia appear to be more frequent in the elderly than in other age groups. Although the term "insomnia" is widely used, there has never been agreement on its precise definition. Generally, it means disturbed sleep or the inability to sleep, but daytime consequences are also usually implied. Disturbed sleep has been more explicitly defined by most authors (cf. 15, 144, 181). The complaint categories include: inability to fall asleep, frequent awakenings, inability to return to sleep, early morning arousal, and any combination of the foregoing.

In general, objective sleep parameters in chronic nonelderly insomniacs, although usually statistically more disturbed than in normal controls, do not show the degrees of severity suggested by the persistence and intensity of the associated complaints (41, 93, 235, 236, 285, 303). Thus, while sleep parameters are often not as disturbed as we might expect in patients with chronic insomnia, can we make this same assumption in the elderly? Published objective sleep laboratory data on elderly chronic insomniacs are very sparse. Polysomnographic testing of elderly patients in sleep disorders centers does not yield helpful data because the test is usually a single night, emphasizing multiple physiological parameters and diagnosis to the detriment of quantifying the actual sleep disturbance. The subjects of Carskadon et al. (41) included five chronic insomniacs over age 65 who estimated subjective sleep parameters on the mornings after the nights in the laboratory. The objective parameters (see Table I) varied greatly among the patients, but showed more disturbance than in younger patients. Impressive in three of the five patients was the large amount of time awake (WASO) after the initial sleep onset. Recently, Frost and DeLucchi (95) reported pretreatment baseline sleep parameters in 6 elderly women (age 67-82) with chronic insomnia who participated in a drug study. These basal parameters showed severe disturbance in all subjects.

TABLE I

Objective and Subjective Sleep Parameters in Five Insomniac Patients

Subject	Minutes TST	Estimated TST	Minutes SL	Estimated SL	Minutes WASO	Estimated # WAKES
M68	441	195	19	60	74	44
M66	528	480	6	20	29	7
M68	364	140	31	310	142	34
M65	372	280	9	30	43	23
F65	417	350	7	5	29	24

A recent unpublished study of noncomplaining elderly individuals at Stanford emphasized a new parameter, the transient arousal, an awakening of 10 seconds or less. Such events are ignored in the standard scoring procedure of Rechtschaffen and Kales (218) used by nearly all sleep centers in their clinical polysomnographic evaluations. Most subjects showed hundreds of transient arousals per night. Systematic quantitative data on transient arousals are not available from other age groups for purposes of comparison, but there is little doubt that they are less frequent.

In summary, the complaint of insomnia is not always predictive of severe objective sleep disturbance. This is particularly true in younger patients. Possible interpretations of apparently normal sleep in chronic insomniacs regardless of age are exhaustively discussed elsewhere (137). On the other hand, it appears that sleep in the elderly is more likely to be impressively disturbed whether or not there is a complaint of insomnia. However, adequate studies of classical sleep parameters in chronic elderly insomniacs are virtually nonexistent.

2. The Complaint of Being Too Sleepy in the Daytime

In the past, the term "hypersomnia" has been loosely applied to a wide variety of conditions including complaints of excessive sleep, persistent daytime drowsiness, sleep "attacks," drug states, comatose states, post-encephalitic and post-ictal drowsiness. Currently, a diagnosis of hypersomnia is usually reserved for objectively verified very large amounts of sleep or a very convincing history, whereas, "excessive daytime sleepiness" is the term applied to the primary complaint of persistent and debilitating daytime drowsiness. The latter complaint is accepted as serious in its own right and does not require the presence of excessive amounts of sleep *per se*. Patients with pathological sleepiness can complain of fatigue and tiredness, weakness, blackouts, learning and memory problems, inappropriate sleep and sleep attacks, hallucinations, "foggy mind," lack of energy, "no pep" (25, 62, 102). Daytime sleepiness is typically accentuated by the use of alcohol (62, 102). About half of all patients who request referral to a sleep disorders center complain primarily of excessive daytime sleepiness. On the other hand, many practicing physicians still do not acknowledge the validity of the complaint (63). Several sleep center case series of younger EDS patients have been published (104, 191, 206, 265) and in nearly every case, a specific diagnosis could be made.

Although many authors feel that daytime sleepiness and fatigue and excessive sleep at night are common problems in the elderly (164, 182, 205, 262, 273), systematic data are extremely sparse. In an observational study of the elderly, Webb and Swinburne (283) concluded that the subjects generally slept much more than is commonly assumed. Finally, the image of the nodding, napping, elderly person dozing all day long on a park bench has a pervasiveness which urges further investigation.

The diagnosis of pathological sleepiness in the elderly has been facilitated by the development of the Multiple Sleep Latency Test (34, 43, 62, 226). This objective clinical test can be applied fairly simply to the elderly population, since it does not require any skill, complex motor performance, sustained attention, or motivation on the part of the subject or patient. Data utilizing this approach in noncomplaining healthy elderly volunteers are presented in a later section.

Is true pathological or excessive daytime sleepiness highly prevalent in the elderly? The question cannot be answered definitively at the present time. However, of the few elderly patients referred to sleep disorders centers, about half are for the complaint of daytime sleepiness.

3. Unusual Nocturnal Behavior

Complaints of abnormal nocturnal behavior are most often rendered by someone in the patient's environment. A common phenomenon in the elderly is nocturnal wandering or disorientation. The term "sundown syndrome" has been applied to extreme cases (217). Manifestations of abnormal nocturnal behavior may also include screaming, talking, moaning, regurgitating, belching, bedwetting, nocturnal ejaculation, scratching, teeth grinding, coughing, etc., each with greater or lesser significance to a sleep disorders specialist.

4. "Normal" Sleep Phenomena

Many sleep-related phenomena long considered entirely normal by the general public should be regarded as important symptoms of sleep pathology. Perhaps the most important of such phenomena is snoring. The presence of notable snoring almost always indicates some degree of impairment of upper airway function and in many cases, a very serious impairment.

III. DAYTIME SLEEPINESS/ALERTNESS AND RELATED FUNCTIONS IN THE ELDERLY

A. INTRODUCTION

It is axiomatic that there is a relationship between sleep at night and the way one feels during the day. It is not always clear, however, what daytime symptoms besides sleepiness/alertness might specifically reflect the quality of sleep at night. Daytime symptoms and signs that have been ascribed to the aging processes and that might be a response to disturbed sleep include the loss of ability to perform highly skilled tasks in a rapid fashion, to resist fatigue, to maintain physical stamina, to unlearn or discard old techniques, and to apply the rapid judgment needed in a changing and emergency situation (207). The tendency for restricted activity, relative boredom, and dependence upon others probably favors daytime sleepiness.

B. DAYTIME NAPS

There is surprisingly little reliable quantitative information on daytime napping in the elderly. Zepelin (299) observed that among men, the number of daytime naps increased with age irrespective of employment status; for women, the tendency to nap was confined to those who were not employed full time. For both sexes, the total sleep time accumulated throughout an average 24 hour period (including naps) was approximately the same after the age of 60 as before 40 (about 7.5 hours). After 60 years of age those who were employed full-time slept 30 minutes less than those not employed.

Various other reports suggest that neither the amount of sleep per 24 hours, nor the need for sleep decreases with age (259, 283, 293, 299). Webb and Swinburne (283) state that "the sleep of the elderly is no less, and in the case of the male, is perhaps somewhat longer though more variable in distribution throughout the 24 hours." Only 1.72 % of those elderly "poor-sleepers" studied by McGhie and Russell (177) admitted taking mid-day naps. Nevertheless, it is legitimate to propose that the aged may be chronically sleep deprived. Johns (138) found that WASO increased with age in males, and was associated with increased amounts of sleep during the day. He concluded that the daytime naps were compensating for for the increased WASO.

C. DAYTIME SLEEPINESS/ALERTNESS

Because healthy, noncomplaining elderly volunteers awaken frequently throughout the night, they appear to have a reduction in total sleep time, and it is reasonable to expect that this sleep deprivation or fragmentation would cause increased drowsiness during the day. If the sleep changes occur because the elderly have less "need" for sleep, however, there would be no reason to propose a direct effect on daytime functioning. Resolution of this very important question has been hampered by the fact that previous studies of nocturnal sleep in the elderly have not included concurrent measurements of daytime function, and no study of acute total sleep deprivation has ever been carried out on elderly subjects.

In recent years, an objective measure of sleepiness has been developed that exploits the most familiar feature of sleepiness as a state of increased tendency to fall asleep. Because the exact time of transition from wakefulness to sleep is relatively easy to specify in polygraphic recordings (218), it has been possible to design a standard situation in which the momentary sleep tendency of an individual can be measured as the speed of falling asleep (sleep latency). Measures of sleep latency repeated throughout the day are now used as an objective indicator of daytime sleepiness. This approach has been validated in studies of total sleep loss in adults (34), repeated measures of sleep latency around the clock (35, 42), observations on patients with narcolepsy (226), and studies of chronic sleep loss (36); and by comparison with data on subjective sleepiness (62).

It appears that amounts of nocturnal sleep in excess of the conventional are required to achieve optimal levels of daytime alertness. Objective studies of daytime sleepiness support this formulation. Prepubertal children who sleep more than 9 hours at night maintain full alertness all day long (37). Adults who sleep 7 to 8 hours at night tend to be objectively sleepy in the daytime, and this sleepiness can be reversed by increasing nocturnal sleep time above the usual amount (38).

The Stanford Sleep Research Center has begun to apply this approach to the study of daytime sleepiness in the elderly. A sizeable group of healthy elderly subjects have been recorded around-the-clock for two consecutive days (40). Nocturnal polysomnography was carried out before daytime testing, and multiple sleep latency tests were administered at two- hour intervals from 0930 through 1930 (six tests daily). Of special interest was the fact that all subjects were in bed from 2200 to 0800 on both nights (10 hours per night). Thus, sleep was largely ad libitum, and a fairly wide range of nocturnal sleep times was seen.

The major finding at night was exactly as expected, sleep was was very seriously fragmented and interrupted. A major factor in the sleep fragmentation was the high prevalence of sleep apnea (see Section IV). However, several subjects had many arousals in the absence of respiratory disturbance. In these cases, other causes are presumed, some known (nocturnal myoclonus) and some unknown. About 60% of the subjects had more than 100 brief or prolonged arousals during a night's sleep.

Overall, these older subjects were more sleepy in the daytime than comparison groups of younger subjects evaluated under identical circumstances. There was a very wide range of individual scores. Several subjects showed daily average sleep latencies of 5 minutes or less on the MSLT. Such low sleep latencies are usually considered to be within the pathological range (61) and are invariably associated with impaired daytime performance. These sleepy subjects were also those who had the most severe nocturnal respiratory disturbances. Overall, the number of brief arousals per hour of nocturnal sleep was the best predictor of daytime sleepiness. The wide range of multiple sleep latency test scores suggests that a substantial number of elderly persons are pathologically sleepy in the daytime even when they do not complain of hypersomnia.

Although it is not known whether elderly people can change their daytime alertness by increasing nocturnal sleep time, the data obtained so far strongly suggest that fragmented sleep in persons of advanced years is not the result of a decreased sleep "need."

D. INDIRECT FACTORS INFLUENCING SLEEP/WAKE FUNCTION IN THE AGED

1. Bed Rest

Bed rest is likely to play an unusually important role in sleep/wake function. Whether increased bed rest and inactivity results from illness, social constraints, or the aging process itself, there are significant consequences. Studies carried out at NASA-Ames Research Center at Moffett Field, California, by Winget et al. (295) show that prolonged bed-rest changes the amplitude and phase of circadian rhythms of body temperature and heart rate. The test subjects (who were not elderly), also had a tendancy to "free- run" with respect to the usual 24 hour rhythms, even though they were in no sense isolated from time or light/dark cues. The observed changes were apparently not caused merely by physical confinement; and exercising during bed-rest did not prevent the development of these abnormal rhythms. Thus, the effects were assumed to be postural.

2. Retirement

Effects of retirement may be associated with significant psychological changes which in turn may affect sleep. On the other hand, the general public's perception of the psychological state of the elderly often does not coincide with information obtained from the elderly themselves. Retirement may also be associated with marked changes in sleep schedule.

3. Institutionalization

Institutional care, such as old age or "rest" homes, has been a popular and growing way of caring for the non-self-sufficient aged. Most investigators agree that a true description of the lifestyle and problems of the inhabitants of old age homes should have high priority. The common conception is that old age homes are often staffed by an inadequate number of relatively unskilled and low paid personnel and that they operate on a small profit margin; therefore these institutions often impose quite strict living regimens in order to cope.

These considerations are said to result in the inappropriate and excessive use of sedative drugs, physical restraint, or confinement, and may cause further deterioration in the elderly patient. For example, the elderly person's natural sleep/wake schedule may not coincide with the institutional organization, so they may be awakened for meals or for medications, or told to go to sleep or keep awake at endogenously inappropriate times. The problems cited above also occur in nursing homes, although physician and other professional health care is usually more immediately accessible.

The activities of the elderly person in a hospital are even more limited than in a nursing home. Since the care is often more professional, they may actually have more logical and appropriate physical management. However the sleeping environment may be even more destructive, and the opportunities for recreation and other activities more circumscribed.

IV. SPECIFIC SLEEP PATHOLOGIES IN THE ELDERLY

A. INTRODUCTION

The past decade has seen an unprecendented expansion of knowledge about specific sleep disorders and the development of special clinical services devoted entirely to these problems. The thrust of these new services or sleep disorders centers is to identify the specific cause of the sleep-wake complaint and to initiate specific treatment whenever possible. The Association of Sleep Disorders Centers (ASDC) was founded in 1975 to formulate standards for accrediting these specialized clinical facilities and to prepare standards for nomenclature, diagnosis and clinical testing (10).

Although sleep disorders history takin provides many useful diagnostic clues and conventional neurological, psychiatric, and medical evaluation can reveal the primary cause of many secondary sleep problems, the core approach in sleep disorders is a comprehensive examination of the sleeping patient. This evaluation is carried out by simultaneous and continuous polygraphic monitoring of a number of physiological variables, which in its standardized form is called clinical polysomnography (12). The standard test must include recordings of brain waves, eye movements, muscle tone, respiratory effort and air-flow, oxygen saturation, heart rate, leg movements, as well as snoring and other vocalizations. A variety of other measures such as blood gases, fiberoptic endoscopy, pulmonary and systemic arterial blood pressure, and hormone secretory patterns, can be carried out during sleep to clarify special problems at the discretion of the physician.

B. DO SPECIFIC SLEEP PATHOLOGIES EXIST IN THE ELDERLY?

Although there is a widespread belief that elderly individuals have great difficulty sleeping and the substantial frequency of sleep-related complaints among the elderly has been thoroughly documented, the number of aged patients seen in sleep disorders centers has been disproportionately small. Nonetheless, several clinical findings and observations lead us to assume that sleep problems in the aged will generally be more frequent and more serious than in any other age group. (a) The specific primary sleep pathologies of adults are largely unremitting. Thus, with new cases continually and cumulatively entering the population, the overall proportion will increase with age. (b) Although the natural histories of most sleep pathologies are completely undescribed and longitudinal data are virtually nonexistent, most experts feel there is a tendency for these problems to worsen with age. (c) Many illnesses that are etiologically unrelated to sleep are either aggravated during sleep (e.g., patients with severe chronic bronchitis have more respiratory disturbance during sleep than wakefulness), or they cause a secondary sleep disturbance. Examples of the latter include insomnia caused by nocturnal pain in arthritis, macroglossia in hypothyroidism causing an upper airway sleep apnea syndrome, and insomnia occurring as a result of nocturnal dyspnea in congestive heart failure. (d) Pre-existing sleep pathologies are likely to be aggravated by the development of other medical problems. The increased incidence with age of many illnesses may therefore tend to increase the severity and apparent frequency of sleep pathologies. (e) Finally, there is evidence that specific sleep pathologies exist in many elderly persons who do not complain about their sleep (see below).

C. SPECIFIC SLEEP DISORDERS

In the autumn of 1979, the Association of Sleep Disorders Centers (ASDC) published its Diagnostic Classfication of Sleep and Arousal Disorders (11). The system gives clear criteria that can be used by sleep disorders specialists and practicing physicians alike. More than 100 specific diagnoses are possible for sleep/wake complaints. (The various diagnostic categories are listed in the appendix.) At the time of this writing (circa January, 1981), several small case series studies of insomnia and hypersomnia using the ASDC diagnostic classification system have been published (15, 64, 122, 235). The first age-independent ASDC cooperative case series study of more than 4000 patients is also being readied for publication.

Although we can now expect rapid progress in extending our understanding of specific sleep/wake diagnoses in the elderly, there is not sufficient information at the present time for a systematic discussion. Only two small case series of elderly patients are available—27 patients from the Pittsburgh sleep disorders center (224) and 83 patients from the Stanford sleep disorders center (51). In the former, age ranged from 55-79 (mean 62); all patients in the latter were over 60 years of age. Approximately half of the patients in both case series complained of insomnia. Most of the remainder complained of excessive daytime sleepiness with a small number complaining of abnormal behavior. Since we cannot discuss all the categories in the ASDC system in terms of elderly patients, we will depart from its strict organization in order to emphasize areas that are clearly important. The official document (11) should be consulted for exact terminology and precise definitions. It is worth mentioning that the recommendations of the 1978 Research Planning Workshop on Sleep and Aging (194) sponsored by the National Institute on Aging including urgent admonitions to learn more about the incidence and relevance of these defined sleep pathologies in the aged.

1. Breathing during Sleep and Sleep Apnea Syndromes in the Elderly

a. Respiration in asymptomatic "normal" volunteers

In the elderly, the absence of a sleep/wake complaint does not mean the absence of sleep pathology. Nowhere is this more apparent than in the area of respiratory function. Because respiratory impairment during sleep is almost certain to be the most prevalent primary sleep pathology in the elderly, it will be discussed first.

Although the study of normal and pathological respiration during sleep has become a major area in medicine and physiology, very little work has been done with either elderly humans or aged experimental animals. Several recent reviews of the area (127, 209) cite convincing evidence that respiratory regulation proceeds differently during sleep as opposed to wakefulness. This difference makes it possible to account for the co-existance in sleep disorders patients of normal breathing during wakefulness and pathological breathing during sleep.

Although a variety of rate changes, pauses, and other breathing irregularities have been described in human REM sleep (9, 250) and confirmed in experimental animals (203), there are few careful quantitative descriptions of the occurrence of more serious respiratory phenomena (apneas and hypopneas) in young, healthy noncomplaining volunteers.

In one of the first such studies, respiratory rate and regularity was described throughout the night in relation to REM sleep and NREM sleep stages in 22 pre-adolescent children by Carskadon et al. (39). Respiratory pauses (5 to 10 seconds) and type and duration of apneas (>10 seconds) were noted. All children had fewer than 30 apneas in more than 9 hours sleep, and no male/female differences were seen. The mean number of apneas per night was less than 8 and the longest apnea was 25 seconds. Guilleminault et al. (116) briefly reported data gathered on a group of normal middle aged (45-60 years) subjects. The greatest number of apneas in a single night was 12 and the males had somewhat more apneas than the females.

The above data contrast markedly with studies on older individuals. The first observations on older individuals were made by Webb (270) and Webb and Hiestand (271) who continuously measuring oxygen consumption (272) in 20 normal volunteers aged 19 to 63. They found that respiration during sleep was very irregular in 9 of 11 subjects who were 45 years or older. Subsequently, Block et al. (19) described sleep apneas, hypopneas, and episodes of oxygen desaturation in normal subjects of whom seven males and one female were in their sixth or seventh decade.

There are several ongoing studies in this very important area. Systematic observations on breathing during sleep in the elderly are being conducted by Carskadon and her colleagues at Stanford, California. Several preliminary reports have been published (32, 33, 40). In the Carskadon study, elderly volunteers are selected on the basis of having no complaint about their sleep and no serious health problem. They are therefore, felt to be the group most likely to have good (undisturbed) sleep and normal respiration during sleep. Table II shows the results from 40 elderly subjects compared to 24 middle-aged subjects.

TABLE II

Apneas during Sleep in Noncomplaining Healthy Volunteers

	Middle Aged	Elderly
N	24 (12M 12F)	40 (18M 22F)
Mean Age:	49.9	73.8
Age Range:	48-60	62-86
Mean Respiration Disturbances/Night:	4.7	50.0
Range Respiration Disturbances/Night:	0-12	0-216
Number with RDI > 5	0	15

Respiration Disturbance = apnea or hypopnea
Hypopnea = 50% reduction of breathing >10 seconds, terminating in arousal.
Apnea = Respiratory pause > 10 seconds
RDI = Respiration Disturbance Index (number of respiration disturbances/hour of sleep)

The large difference in respiration distubances between the two groups is highly significant. Recalling that each apneic pause is terminated by an arousal, we may conclude that 37.5 % of the elderly subjects experience five or more interruptions of their sleep per hour. These findings suggest that age-related respiratory impairment may account for a great deal of the sleep fragmentation in elderly subjects reported by many investigators. Thirty percent had ten or more respiration disturbances per hour. Finally, there were no significant differences between males and females.

Ancoli-Israel and Kripke (7) have studied 15 healthy elderly volunteers who did complain considerably about their sleep when questioned. They found that 9 (or 60%) had a sleep apnea syndrome most commonly of the upper airway type. Additionally, McGinty and Arand (178) has reported work on elderly VA patients who were asymptomatic with regard to sleep. He found that one-half of a small sample had severe oxygen desaturation during sleep.

We note that none of the above data are from patients in sleep disorders centers. This fact raises the issues of "normal" sleep processes in the elderly and whether sleep matures or deteriorates with advancing years. It should be noted that most sleep disorders specialists regard 30 apneas per night as the upper limit of normal. Application of this criterion would mean that at least a third of all elderly individuals who are judged to be in good health when awake would receive a clinical diagnosis of sleep apnea syndrome.

b. Snoring in the Elderly

When the lower vibratory frequencies accompany normal breath sounds, the sleeper is snoring. Snoring ranges widely in intensity, quality, and persistence from occasional faint gurgling to constant, incredibly loud, braying, snorting, choking, rumbling cacophonies.

The presence of snoring almost always indicates some degree of impairment of upper airway function and in many cases, a very serious impairment. Lugaresi and his colleagues (169) carried out pioneering observations of blood pressure during sleep in normal adult males who were heavy snorers. All subjects showed hemodynamic abnormalities during sleep. (The oldest participant was 63 years old.) Guilleminault and his colleagues have repeatedly emphasized that heavy snoring almost always precedes development of an upper airway sleep apnea syndrome and is the most important symptom of the illness (110, 111, 116, 117). Studies measuring intrathoracic pressure changes in heavy snorers clearly show that airway resistance and the work of breathing are greatly increased.

In an extremely important epidemiological study, Lugaresi and his colleagues (172) found that the prevalence of snoring increases with age. Almost 60% of males in their sixties and 45% of females are habitual snorers. The Lugaresi study also suggests that lifelong nonapneic snoring may be a very important risk factor in the development of cardiovascular disease. Similar relationships to hypertension were recently reported by Pollock et al.(213) in a smaller study.

c. Sleep Apnea Syndromes in Patients Referred to Sleep Centers

Of the three types of sleep apneas- upper airway, central and mixed- the former is most often found in patients complaining of EDS. Pathological apneas during sleep were first reported in 1965 by Gastaut et al. (96) who studied Pickwickian patients. Sleep-induced respiratory dysrhythmias in nonobese patients were described by several groups in the late 1960's (73, 160, 171). More comprehensive accounts as well as terminology and definitions may be found in numerous sources (48, 105, 106, 109, 111, 113, 116, 162, 163, 242). Other clinical symptoms include inordinately loud snoring, abnormal behavior during sleep (which is mainly the result of the struggle to breathe), enuresis and morning headache.

In addition to primary sleep apnea syndromes in which the upper airway is entirely normal in the waking state, almost any condition that compromises upper airway function can give rise to a secondary sleep apnea syndrome in predisposed individuals. Conditions that may aggravate sleep-related apneas include micrognathia, cervical cordotomy, myotonic dystrophy, poliomyelitis, Shy-Drager syndrome, acromegaly, hypothyroidism with myxedema and macroglossia, amyloidosis, and hypertrophic tonsils in children.

At the time of diagnosis, the great majority of cases are over 40 years old. Though the age of onset is usually uncertain, heavy snoring can precede clinical symptoms by many years (117, 172). Most sleep disorder clinicians view upper airway sleep apnea as a terminal illness, which if untreated will sooner or later result in sudden death during sleep or decompensation of the impaired cardiovascular system at any time.

The diagnosis of sleep apnea syndrome was dramatically high in elderly patients complaining of daytime sleepiness in the Stanford case series. Twenty-seven (71%) of 38 patients received this diagnosis. The majority were of the upper airway type. Two of the seven Pittsburgh patients had sleep apnea.

Although typically associated with excessive daytime somnolence, sleep-induced ventilatory impairment may present with insomnia. The type of apnea associated with the complaint of insomnia is usually predominantly central (107, 108). In central sleep apnea, snoring can be present, but other complaints seen in upper airway sleep apnea are usually not prominent. Reynolds et al. (224) diagnosed 3 of 19 (15.8%) insomniacs as sleep apnea syndrome while Coleman et al. (51) found 7 of 39 (17.9%).

d. Nocturnal Oxygen Desaturation in Chronic Obstructive Lung Disease

During the past few years, the effect of sleep on breathing in patients with chronic obstructive airflow disease (COAD) has finally received the attention it deserves. COAD patients show nocturnal worsening of hypoxemia (49, 87, 103, 128, 296) which occurs predominantly in REM sleep. These episodes of hypnoxemia are accompanied by pulmonary and arterial blood pressure increases and cardiac arrhythmias. Most patients have severe hypopnea whose mechanism is unknown and some have predominantly upper airway sleep apnea. These findings have extremely important implications for the use of nocturnal oxygen therapy in severely ill COAD patients.

2. Periodic Leg Movement During Sleep (Sleep-related Myoclonus)

First described by Symonds in 1953 (256), sleep-related myoclonus consists of repetitive movements of the lower extremities during sleep, including rapid partial flexion of the foot at the ankle, extension of the big toe, and partial flexion at the knee and hip (114, 170, 173). Periodicity and sterotypy are the most distinguishing feature of the movements. When the movements are vigorous and continual over long periods of time, their ability to cause insomnia is obvious. A related disorder, restless legs syndrome (47, 74, 75, 76, 94), is also a cause of insomnia and can be extremely severe.

No insomniacs in the Pittsburgh study (224) had nocturnal myoclonus, while 13 were found in the Stanford series (33.3%) and 2 patients had restless legs syndrome (51). Several elderly noncomplainers also reached the criterion for a diagnosis (40). There is little question that the incidence of nocturnal myoclonus increases with age and that the likelihood of an associated sleep-wake complaint is related to the absolute number and intensity of the leg movements.

About one-half of a series of cases of nocturnal myoclonus were associated with excessive daytime somnolence according to one investigator (52). In a series of sixteen patients was reported by Guilleminault et al. (114), fifteen complained of disrupted nocturnal sleep and daytime fatigue, while one complained of excessive sleep and daytime fatigue. Notably, the mean age was 54.8 and three of the individuals were over 65. Six of the 38 elderly DOES patients (15.8%) had nocturnal myoclonus in the Stanford series (51).

3. Additional Causes of Insomnia in the Elderly: Disorders of Initiating and Maintaining Sleep (DIMS)

a. Psychophysiological Insomnia

The transient variety of psychophysiological insomnia is very common and generally associated with acute emotional conflicts or reactions. Persistent insomnia of this sort may result from a cycle in which the place of sleep or the attempt to sleep becomes associated with frustration and arousal, thereby increasing the sleep loss. In the aged, multiple arousals through the night are more common than prolonged sleep latency. Four of 19 insomniacs in the Pittsburgh series received the diagnosis of persistent psychophysiological insomnia and 12 of 39 (31%) at Stanford.

b. Psychiatric Insomnia

Psychiatric disturbances are often associated with a complaint of insomnia. Personality disorders may lead to poor sleep or to hypochondriacal complaints of poor sleep. Unipolar affective disorder commonly includes repeated awakenings and early-morning wakefulness, reduction of Stage 4 sleep, and short REM latency; and this reduction in REM latency may be more significant among the elderly (161). In the Pittsburgh series (224) of elderly patients, 9 of 19 insomniacs (47%) received a diagnosis of primary affective disorder (depression). In the Stanford series (51), psychiatric cause was implicated in 18% of the elderly insomniacs. The difference is probably due to the type of patients encountered in the Western Psychiatric Institute (Pittsburgh).

Depression often occurs as part of the complex changes associated with retirement. One stress that may result in depression in aging women has been referred to as the "empty nest syndrome" (129, 197, 228). The woman's responsibilities often decrease when children leave the home and her husband is preoccupied with his work. The view of herself as no longer needed begins to undermine a woman's self esteem (27). Unfortunately, this phase of life often coincides with the time a woman experiences menopause (71). Thus biological and psychological factors can combine to produce depression in older women (197), typically associated with disturbed sleep. Cohen (50) describes a "nocturnal neurosis," which he sees in about 50% of the elderly in medical consultations in mid-town Manhattan.

c. Insomnia Associated with Use of Drugs or Alcohol

Use of drugs or alcohol frequently affects sleep adversely. Tolerance to or withdrawal from a wide variety of sedative/hypnotics and other CNS depressants can produce insomnia. Sustained use of stimulants may also be implicated in insomnia. Drugs used to treat nonsleep disorders in the aged may secondarily induce insomnia. A wealth of information much of it relevant to the elderly is contained in two recent books by Clift (46) and Mendelson (180). Eight of 39 DIMS patients (20.5%) in the Stanford series (51) and one in the Pittsburgh series (224) received a drug related diagnosis. This diagnosis often co-exists with other sleep-wake diagnoses.

d. Insomnia Due to Other Conditions

A wide variety of other medical, toxic, and environmental conditions are associated with insomnia, almost all of which are more likely to be encountered by the aged. Such patients are rarely referred to sleep disorders centers. However, conditions which are highly prevalent among the elderly such as arthritis, nocturia, nocturnal dyspnea, chronic brain syndrome, and so forth, are almost by definition associated with disturbed sleep. Gerard et al. (97) made a special point of the importance of chronic pain in this regard.

4. Disorders of Excessive Somnolence (DOES) in the Elderly

a. Narcolepsy

Narcolepsy has been called a disease of REM sleep (68, 130, 225). Various estimates (65, 66, 233) suggest that more than 250,000 people in the United States have this illness. Typically, narcolepsy begins in the second decade of life, although rarely its onset may be as late as the sixth and seventh decades; as far as is known, the syndrome never remits. Two of the 7 (28.6%) Pittsburgh elderly patients had narcolepsy and four of 38 sleepy patients in the Stanford series (10.5%).

b. Hypersomnolence Associated with Use of CNS Stimulants

Tolerance to or withdrawal from CNS stimulants and sustained use of CNS depressants can be associated with excessive daytime somnolence. Often overlooked, particularly in the elderly where drug metabolism may be slower, is daytime carryover of long-acting hypnotics taken at bedtime (180). Use of drugs for common nonsleep disorders may secondarily induce excessive somnolence. Such drugs include antihistamines, "major" and "minor" tranquillizers, methyl-dopa (an anti-hypertensive drug), and tricyclic antidepressants, especially amitryptyline. The diagnosis was made only once in the two case series of elderly patients.

c. Other Conditions

Other medical, toxic or environmental conditions are associated with disorders of excessive somnolence. Post-viral sleepiness and fatigue is well known, and in the elderly, chronic brain syndrome can be associated with hypersomnolence.

5. Dyssomnias Associated with Disruptions of the 24-hour Sleep/wake Cycle

The explicit notion that sleep disorders diagnoses can be made in this area of function is quite recent (57, 64, 149, 154, 183, 185, 286) although it has long been known that schedule changes, shift work, and transmeridian travel can lead to sleep disturbance. There is a very strong feeling that circadian rhythms abnormalities will be important in the elderly for reasons elaborated in the following section on this topic. The fact that only one diagnosis in this category, a Delayed Sleep Phase Syndrome, was made from the total of 110 patients in the two elderly case series reflects ignorance rather than true prevalence. The history of early morning arousal and evening drowsiness common among elderly individuals suggests the presence of an "advanced sleep phase syndrome."

5. Dyssomnias Associated with Sleep, Sleep Stages, or Partial Arousals

There are a group of clinical conditions that are not disorders of the sleep/wake processes per se. They are intrusive phenomena either appearing exclusively in sleep or exacerbated by sleep. Sleep talking and night terrors are very common in childhood. The nocturnal confusion and wandering so commonly associated with chronic brain syndrome is probably the most common problem in the elderly (217). Sleep related cardiovascular symptoms, enuresis, gastroesophageal reflux, and sleep related epileptic seizures are frequently seen in elderly persons. Asymptomatic polygraphic abnormalities are classified in this overall category, and include such events as the recently reported sleep-related cardiac arrhythmia consisting of prolonged asystoles only during REM sleep (112). Although this syndrome has not been described in elderly persons, current microprocessor technology would allow screening of large elderly populations with ambulatory cardiac monitors (86).

V. BIOLOGICAL RHYTHMS AND SLEEP/WAKE FUNCTION IN THE AGED

A. INTRODUCTION

Present evidence suggests that biological rhythms in the elderly may be an important variable in geriatric medicine. In this regard, the regular alternation of sleep and wakefulness is a fundamental endogenous biological rhythm, which in normal circumstances is able to entrain other circadian rhythms. In addition, components of the sleep/wake cycle (such as the tendency for SWS and REM sleep, subjective sleepiness, and sleep latency) also vary with circadian periodicities (43,56,187,279,280,288). It now appears that abnormalities of the sleep/wake cycle and changes in its relationship to other rhythms may account in part for many of the difficulties of old age. Issues concerning circadian rhythms are complex, however, because there are many ways in which a biological rhythm may be abnormal.

Much is known about the normal responses of circadian rhythms to manipulations. For example, when humans or animals are placed in an environment free of time cues, their circadian rhythms usually adopt a "natural" period that is different from 24 hours. This is known as "free-running." Pittendrigh and Daan (211) used rodents to demonstrate that the period (tau) of the free-running circadian rest-activity cycle decreases with advancing age. The authors also point out that the maintenance of a stable relationship among circadian rhythms of various physiologic functions is thought to be an important element in "normal" physiological well-being. Thus, if aging has a variable affect on individual rhythms, their mutual phase relations would alter. Such an alteration would produce systematic change in the daily temporal organization of the aged animal which could, in principle, be a cause of certain physiological effects commonly attributed more simply to "age." Similar experiments have been carried out by Eskin (77), Wax (269), and Wenzel et al. (290).

Other studies have shown additional age-related changes in biological rhythms. Changing the rest/activity cycle by repeatedly manipulating light and darkness, has been shown to reduce the life span of such organisms as the blowfly (8), fruitfly (212), codling moth (125), mouse (118), and rat (126). It is notable however, that the reduction in life span was not always observed when the manipulation was initiated early in life (118,126). Age-related changes in circadian susceptability to noxious environmental factors may be especially relevant to the elderly. Halberg et al. (119) showed that the susceptibility of mice to audiogenic convulsions changed with age and was consistently higher during the night, when mice are ordinarily active.

B. AGE-RELATED CHANGES IN ANIMAL SLEEP-WAKE CYCLES

Rosenberg and Rechtshaffen (230,232) found that aged rats under normal light-dark conditions showed substantial disruption of the normal circadian distribution of polygraphically recorded sleep and wakefulness. The old rats were capable of achieving an acute 180 degree phase shift in sleep and wakefulness, although the rate of shift was slower than for young rats (229).

C. AGE-RELATED CHANGES IN THE HUMAN SLEEP/WAKE CYCLE

It appears likely that many abnormalities of circadian rhythms present clinically as sleep/wake disorders (see appended Diagnostic Classification of Sleep and Arousal Disorders, 1979). These conditions include acute and chronic shift work dysomnia (18,26,54,118,260,268) and jet lag (166,198), delayed sleep phase (57,58,286), advanced sleep phase (149), non-24- hour circadian rhythms (185), reversed sleep/wake phases (288), and generally disorganised circadian rhythms. In addition, certain patients may have disruptions in the circadian distribution of a single sleep component, such as REM sleep.

Many elderly persons show changes reminiscent of circadian dyschronosis. For example, with aging there appears to be a breakdown of the biphasic pattern of sleep and wakefulness and a return to the polyphasic alternation of sleep and wakefulness encountered in an infant (276). The phase of the sleep/wake cycle may also change. Many older people are "larks." Tune's study of 509 subjects of different ages showed that increasing age was associated with earlier times of falling asleep and awakening (261,262). Studies of one elderly insomniac by Kamei et al. (149) in an environment isolated from all time clues, showed evidence of an unusually advanced sleep phase and short circadian period. Any such phase-advance must also displace the phase of many other circadian rhythms. In the same way, regular daytime naps, regardless of their etiology, may modify the sleep/wake rhythm and other associated biological rhythms.

Brezinova (23,24) attempted to determine whether changes in the sleep of the elderly were due to a change in the period of the REM/NREM cycle. Although many other sleep parameters were found to be different, the period of the average REM/NREM cycle appeared little changed. Other studies have shown that the circadian rhythms of sleep/wake and rest/activity may become dissociated (188,291). In this regard, it is of interest that both normal aged and insomniac patients sometimes have periods of activity broken by frequent naps, and at other times endure periods of inactivity during which sleep is disrupted and disorganized.

There is some indication that elderly people may be less tolerant to phase-shifts of the sleep/wake cycle (251). Preston (214) reported sleep deficits in airline pilots operating on transmeridian routes, and found that the older the pilot, the greater the cumulative sleep loss.

Any change in circadian rhythms associated with the changed sleep-wake function of the elderly might not be caused by changes in sleep itself. Winget and his co-workers (295) found that normal (nonelderly) volunteers subjected to 56 days of absolute bed rest showed evidence of desynchronosis and free- running circadian rhythms of heart rate and body temperature. Of particular relevance to the problems of the aged, these changes did not seem to be due to physical confinment or lack of exercise, but appeared to be related to postural changes alone.

D. AGE-RELATED CHANGES IN OTHER CIRCADIAN RHYTHMS

The circadian cycle of deep body temperature is one of the most stable biological rhythms. Carandente et al. (30) found that aging (or an interaction between aging and handling) altered circadian thermovariance of male inbred stroke-prone rats. Halberg, Yunis, and their coworkers (118,119,297) found complex changes of the circadian temperature rhythm of aged rats and mice. Differences in the speed of rhythm adjustment as a function of age have also been observed in shift workers by Reinberg et al. (221,222).

Sasaki (244) claims that the circadian pattern of body temperature in aged humans is characterized by a phase advance and a lack of stability. This is ascribed not only to lowered sensibility to stimuli and reduced function of effector organs, but to poor performance of the regulatory network, including feedback pathways. Lobban and Tredre (168) found that the oral temperature of elderly subjects showed a clear circadian rhythm with normal phase, but the rhythm of urinary electrolyte excretion was changed from that of younger subjects.

A recent study of urinary epinephrine (E) and norepinephrine (NE) excretion in elderly subjects (69,70) showed complex age-related alterations in their circadian rhythms. Prinz et al (216) found that plasma levels of E were unaffected by age, but NE levels were greater in the old humans during both day and night. The increase was greatest at night and in those subjects with most disturbed sleep. These findings led the authors to postulate that the typical sleep changes found in the elderly may be related to increased sympathetic nervous system activity.

Neuroendocrine rhythms probably have profound involvement in aging. Dunn et al. (72) studied the circadian rhythm of corticosterone in rats and reported little change with age. In studying humans, Kreiger (157) found that age had no effect on the circadian rhythm of plasma cortisol. Serio and his associates (247) found the phase of the circadian rhythm of cortisol to be delayed in older people, and the presence or absence of sleep complaints appeared to make little difference. Montalbetti et al. (189,190) measured plasma cortisol and found a circadian rhythm of normal amplitude but with an altered phase. The change in phase was thought to be a possible result of sleep disturbance in old age. In other studies, Montalbetti and his colleagues found that the cortisol rhythm was normal in the healthy elderly and elderly patients with cerebrovascular hemiplegia, but abnormal in the elderly blind (53, 60). It seems probable that growth hormone secretion does not occur with a true circadian rhythm but passively follows the appearance of stage 3 and 4 sleep (SWS); and both SWS and growth hormone secretion are minimal in the elderly (31,59,83). Murri et al. (193) confirmed the marked decrease in growth hormone in the elderly, but also found that sleep associated prolactin secretion was present and similar to that of a normal young adult.

In view of the considerable amount of medications taken by the elderly, it is potentially very significant that previous animal and human work has demonstrated the existance of circadian rhythms of drug efficacy and toxicity (123,220,223). Although it seems likely that such rhythms would be especially relevant in the elderly, we know of no studies of "chronopharmacology" in the aged human.

E. BIORHYTHM STUDIES IN OLD AGE HOMES

Wessler et al. (291) evaluated activity and sleep-wakefulness of institutionalized elderly patients. These investigators found a high-order circadian regularity and synchronization between individuals from day to day and concluded that the strict institutional regimen was probably beneficial. The observational study by Webb and Swinburne (283) is one of the very few investigations to record the actual life style and sleep/wake habits of all members of an aged community. These individuals were all physically unstable but without extreme pathology; they had regularly scheduled meals, but sleeping habits and activities were self-imposed. Any sleeping medication was withdrawn before the study. The authors reported that the basic circadian patterning of sleep placement and amount was present despite the fact that the subjects spent almost half their time in bed, had broken nocturnal sleep, and several daytime naps. In another study, Cahn, Folk, and Huston (28) found that three of four old men exhibited either a phase shift or desynchrony among their rhythms of heart rate, body temperature, urine flow, and potassium excretion.

Scheving et al. (245) examined 9 elderly residents of a "nursing" home in Coushata, Louisiana. This study appears to be one of the most thorough investigations of its type. All nine subjects had chronic cardiovascular disease and were receiving many medications. Perhaps the most notable finding was the extreme variability of many circadian rhythms.

F. PATHOLOGY IN THE AGED: CIRCADIAN FACTORS

Combined mortality data show that death from any cause is most common during the nocturnal sleep period, with the peak occuring just before morning arousal (0600 hours) (249). Unfortunately, age-related data are not available.

Psychiatric disorders, blindness, and organic disease of the CNS, conditions that are common in the elderly, have all been associated with circadian disruptions. Various forms of depression (including manic depressive illness) have been associated with changes in the circadian rhythms of REM sleep, the overall sleep/wake cycle, cortisol secretion, and other factors (2,28,208,238,239,240,241,246,267). Organic disease of the CNS appears to effect the circadian rhythm of rest and activity and may interact with changes in the circadian rhythm of cerebral blood flow.

It is notable that the prevalence of "legal" blindness increases sharply with age and that approximately half of all the blind people are 65 years of age or older (195). This information appears most relevant to sleep disorders and biological rhythm dysfunction, in view of evidence that sleep disorders are very common and significantly incapacitating in the blind community (186) and that blind people have abnormalities in their circadian rhythms (60, 134, 156, 168, 174, 185, 204, 248).

VI. SEDATIVE/HYPNOTICS FOR TREATING INSOMNIA IN THE AGED

A. INTRODUCTION

In 1974, patients over age 60 received approximately one third of all secobarbital and diazepam prescriptions (14). In a more recent estimate, the Food and Drug Administration (90) and the U.S. Senate Subcommittee on Longterm Care (255) reported that 25% of the nation's prescription drugs are used by the elderly, although they make up only 10 per cent of the present U.S. population.

A review of the literature in this area suggests the general conclusion that the toxicity profile of a given hypnotic may be very different in young adults compared to the elderly. Thus chloral hydrate, which enjoys a reputation for minimal side effects, may produce confusion and hallucinations in a large percentage of nursing home patients (155). Flurazepam has an increasing incidence of toxic side effects with progressive age (219); reports have ranged from generally mild side effects in 7.1 percent of patients over 80 (101) to a spectrum of more severe problems such as ataxia, confusion and hallucinations in 26 per cent of nursing home patients over 60 years old (176). High toxicity of nitrazepam in the elderly has also been recently documented (100). When clinically significant drowsiness is considered, phenobarbital (in contrast to benzodiazepines) does not appear to show an age-related increase in deleterious effects (22). The net result is that in patients over 60, the incidence of drowsiness may may be about the same (10.9-12.1 percent) with phenobarbital, diazepam, and chlordiazepoxide (22). Such findings imply that the general body of knowledge about the safety of sedatives/hypnotics, largely derived from studies of younger adults, does not necessarily apply to the elderly. Finally, in view of all these considerations, a report on the use of over-the-counter hypnotics for suicide by elderly persons is particularly poignant (6).

B. USE OF HYPNOTICS BY NONINSTITUTIONALIZED ELDERLY

Several aspects of hypnotic use assessed by questionnaires are discussed in earlier sections. In a telephone survey (115) of the problem of insomnia in the San Francisco Bay area that contacted 549 noninstitutionalized indidviduals, more than 100 were 65 or over. Forty-eight percent of this group reported using sleep medication "every night" or "frequently," which was the highest percentage of any age group. Similar data are available from the National Institute on Drug Abuse (NIDA) in their 1977 publication on the risks and benefits of sedative/hypnotics (55). The pattern of sedative/hypnotic use in the elderly is also indicated by a NIDA-sponsored study of 447 noninstitutionalized elderly subjects in the Washington, D.C. area. Sixty-two percent of respondents took prescription drugs daily; of these 13.6 percent were receiving sedative/hypnotics daily. Of those receiving sedative/hypnotics on any dosage schedule, 40.5 percent took them daily, 40.5 percent only when needed, and 18.9 percent one or more times per week (219). Excellent data by Boethius and his colleagues (20,21) shows higher use in the older age groups but a very recent decrease in usage overall. Kripke et al. (158, 159) have excellent data from the original Hammond studies that clearly implicate more frequent sleeping pill use in older age groups. Kesson et al. (152) in a survey of drug use in general medical patients find benzodiazepine hypnotic use higher in older persons.

C. USE OF HYPNOTICS BY INSTITUTIONALIZED ELDERLY

Nearly everyone who has experience or knowledge about the use of hypnotics in geriatric institutional settings feels it is an abomination. For example, the study of Derbez and Grauer (67) mentions that all patients who were considered for their study had sometime in the past received hypnotics every night. Marttila et al. (176) stated that 26% of 750 patients in "intermediate care facilities" were medicated routinely with flurazepam, which suggests that the overall percentage was much higher. A U.S.P.H.S. survey of physicians' prescribing patterns in skilled nursing facilities showed that prescriptions for sedative/ hypnotics were written for 94.2 percent of the 98,505 patients studied (264). Mulligan and O'Grady (192) noted that half of more than 189 elderly patients in an institutional setting were receiving some hypnotic medication nightly. Probably much of the tendency for routine or prophylactic use in nursing homes goes back to the time-honored practice of prescribing p.r.n. sedation routinely in general hospitals. It is often said that the routine nocturnal sedation of patients is really for the benefit of the staff.

D. EVALUATION OF HYPNOTIC EFFICACY IN NONGERIATRIC POPULATIONS

According to Goodman and Gilman (99) hypnotics are drugs that "promote drowsiness." Although promoting drowsiness does not itself insure improvement of insomnia, it is widely assumed that the amount and/or the quality of nocturnal sleep is inevitably improved when a drug that has such an action is ingested at bedtime. It is further assumed that this will cause an improvement in daytime function, alertness, and overall sense of well-being. These untested assumptions have presumably led to widespread use of hypnotics in medical practice. Sleep laboratory studies have been used to document the "improvement" in nocturnal sleep, and this type of evaluation is recommended in the current FDA guidelines for the clinical evaluation of new hypnotic compounds (89). In addition, these guidelines also recommend "geriatric samples generally also should be studied separately, as responsiveness in different age groups can vary greatly." The recommendations do not, however, include sleep laboratory studies in older patients. This is a very serious omission.

The Institute of Medicine (IOM) of the National Academy of Sciences, recognizing the importance of the issues associated with hypnotic drugs, recently carried out a study on Sleeping Pills, Insomnia and Medical Practice (137) for the White House and the National Institute of Drug Abuse. The IOM critical review of more than 150 efficacy studies found that no benefit from the use of sleeping pills had ever been satisfactorily documented.

The many deficiencies associated with past efforts to establish hypnotic efficacy, particularly in sleep laboratory studies, are exhaustively discussed in the Institute of Medicine report (137) and in its Technical Supplement, in a new book by Dr. Wallace Mendelson (180), and in a comprehensive review of the literature on sleep and aging by Miles and Dement (184). Among many serious deficiencies of hypnotic efficacy studies, two must be mentioned here: (a) the studies very rarely assess the problem of daytime carryover and impairment of performance; (b) the effect of hypnotics on pulmonary and cardiovascular physiology during sleep have not been evaluated.

Routine prescription of multiple psychoative drugs in the elderly has often been criticized (1, 179). As common sense would suggest, the number of toxic interactions does indeed increase with the number of drugs consumed (132). In a study of geriatric psychiatry patients in the VA system, it was found that physicians tended to continue the same or greater dosage of the initial medication when giving additional psychoactive drugs (92). A second cause for the increased incidence of toxic reactions is a decrease or change in the ability to absorb, metabolize and excrete drugs, which accompanies old age (132). Various aspects and ramifications of these changes have been described (133,227). Effects have included intoxication, secondary complications, (e.g., drug-induced hypotension), and disinhibition reactions that include restlessness and aggression (165). The latter, which are particularly troublesome, have often been associated with barbiturates, but occur with all classes of sedative/hypnotics (165).

E. HYPNOTIC EFFECTIVENESS IN THE ELDERLY

Five years ago, Roth et al. (234) stated, "to date, we have not been able to find a single sleep laboratory study evaluating hypnotics using a geriatric population." The IOM study (137) was also unable to find a single published report of sleep laboratory studies of hypnotic efficacy in the elderly. This is a shocking neglect in view of the disproportionate use of sleeping pills by older persons, the age-related changes in drug metabolism, and the much higher incidence of sleep-related respiratory impairment and cardiovascular disease. At the time of this writing, one sleep laboratory study (95) of hypnotic efficacy utilizing elderly subjects has appeared in the scientific literature (see below).

How have hypnotics been evaluated in the elderly? They have been evaluated in the so-called "clinical study" which relies upon questionnaires, patient reports, observations by nurses (usually the specifics of such observations are not given), and occasional interviews. Such approaches for evaluating sleep have been shown to be unreliable when compared to objective parameters (41).

The subject selection criteria are typically vague but usually based on patient complaints. In many cases, subjects for these studies are patients who have been using hypnotics regularly, and yet the study duration is comparatively short and there is no clear statement about withdrawal from previous drug therapy. Most studies of hypnotics in aged populations are of relatively short durations although the actual use in practice is often much longer.

The most recent clinical studies (167,196,201,266) offer more of the same with regard to methodology of hypnotic efficacy in geriatric populations. Current fashions were reflected in the fact that only benzodiazepines were tested, and there was slightly more emphasis on daytime side effects and performance measures.

No study has addressed the issue of whether the performance, motor coordination, and balance of any elderly patient was seriously impaired when aroused from the actual sleep period shortly after ingesting an hypnotic medication. This is an important issue, since under ordinary circumstances, a user of sleeping pills will occasionally have to respond to some nocturnal emergency. Its is particularly important in geriatric users in whom a fall is more likely to be complicated by fractures or other serious injury.

Frost and Delucchi (95) have recently published the first sleep laboratory study of hypnotic efficacy using elderly subjects. Flurazepam was administered hs for seven consecutive nights to 6 women (age range, 67-82 years) at a dose of 15 mg, one-half the dosage usually prescribed for younger patients. Drug nights were compared to placebo baseline and placebo withdrawal. Total sleep time was substantially increased in the group from a pretreatment baseline mean of 344 minutes to an overall treatment mean of 427 minutes. Sleep latency was reduced from 51 minutes to 21 minutes, and total wake time from 135.8 minutes to 54.9 minutes. In spite of these clear changes in nocturnal sleep, it is not clear that the patients experienced a benefit from the medication. Changes in daytime performance or sleepiness/alertness levels were not measured. However, two subjects complained of daytime drowsiness.

Even though the design and reporting of many past sleep laboratory studies have been inadequate, they hold considerable promise for evaluating the risk/benefit ratio of sleeping pills in geriatric populations. Recently, detailed revisions of the current FDA Guidelines (89) for evaluating hypnotic efficacy were submitted by a select committee of sleep researchers, sleep disorders specialists, and pharmaceutical manufacturers representing the two professional societies- Association for the Psychophysiological Study of Sleep and the Association of Sleep Disorders Centers. The committee's recommendations include the addition of daytime measures of performance and sleepiness/alertness, as well as pulmonary and cardiovascular measures during sleep, and above all, specific sleep laboratory studies of the efficacy of hypnotics in treating elderly patients.

F. SLEEPING PILLS AND SLEEP APNEA

There is currently no published study on the effect of hypnotics on respiration during sleep. The fact that hypnotics given at bedtime depress central respiratory drive in the same patients awake the next day (237) strongly suggests that this depression may be more pronounced when the patients are asleep. In addition, respiratory control mechanisms are sufficiently different during sleep (c.f. 209) as to require specific assessment of hypnotic effects on respiration during sleep. It is likely that the impact of hypnotics will be most serious in individuals who complain of transient or chronic insomnia and have an unsuspected primary or secondary sleep apnea syndrome. As was documented in earlier portions of this review, sleep apnea syndromes and unsuspected respiratory disturbance during sleep appear to be have a dramatically increased prevalence in both complaining and noncomplaining elderly. The data on healthy noncomplaining elderly volunteers is the best current estimate of the lower level of sleep apnea prevalence. Since this prevalence appears to be at least 30%, it appears highly likely that sleeping pills will be inadvertently prescribed for sleep apnea victims quite often. In view of the extraordinary importance of this issue, we must mention some unpublished anecdotal data and fervently recommend systematic studies in the future.

In four cases of borderline or unambiguous sleep apnea syndrome, respiration was recorded during sleep before and during treatment with sleeping pills. Two cases were middle aged individuals with upper airway sleep apnea. The first case* showed a mean of 11 apneic episodes over four consecutive baseline nights. On the first night of flurazepam 30 mg, he showed 22 apneas; on the second night, 100 apneas were seen. The second case, had about 300 repetitive episodes that averaged about 15 seconds in length before sleeping pills. When he was given flurazepam 30mg on one night, the mean length of the apneas was doubled and several very long (>one minute) episodes appeared for the first time. One 72-year-old subject who had severe central sleep apnea was given 30mg flurazepam. Their number of sleep apneas did not increase with the medication; however, the duration was alarmingly increased from about one minute to three minutes. One apneic episode on the drug night was terminated by the experimenter when it reached five minutes in length. A second elderly subject with mild central sleep apnea was given 15 mg flurazepam on a single night. He had 90 apneas with a mean length of 15 to 20 seconds during the baseline. On the drug night, he had 120 apneas averaging 50 to 60 seconds in length. In light of these results, the earlier recommendations of Pines et al. (210) to treat sleep disturbances in patients with respiratory disease with flurazepam should probably be disregarded.

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* We are indebted to Dr. Wallace Mendelson for contributing the data derived from this case.

VII. FINDINGS AND RECOMMENDATIONS TO THE WHITE HOUSE CONFERENCE ON AGING

Disturbed sleep, which is an important cause of human misery and ill health at any age, appears to be ubiquitous among the elderly. In view of this, the most impressive fact about sleep and aging is how little research has actually been done. Readers of this review must inevitably be surprised and disappointed by the major gaps in our knowledge about sleep/wake function in advancing years.

One of the most shocking examples of this neglect involves sleep laboratory studies of hypnotic safety and effectiveness. Although sleep laboratory methodology and sleep disorders expertise have been applied to other populations, only one tiny study has been carried out with subjects over age 65. In other words, although the elderly have always been the chief users of sleeping pills, essentially nothing has been learned about hypnotic safety and efficacy in this age group utilizing modern sleep laboratory methodology.

The participants in the 1978 NIA Workshop on Sleep and Aging (194) considered many of the areas covered in this "white paper." In general, we confirm and extend their recommendations but add much more urgency, particularly regarding the alarming extent of the sleep apnea problem which was not entirely clear in 1978. We further find that even in these days of restricted priorities, investigation of many aspects of sleep and aging deserves prompt and effective support. There seems a very good possibility that the results of such investigations could often be translated into immediate practical benefits for elderly individuals.

We highlight and strongly endorse the following research areas:

A. BREATHING DURING SLEEP

Breathing becomes impaired in a very high percent of older individuals when they fall asleep. More than half of elderly patients evaluated at sleep disorders centers have sleep apnea, and risk increases dramatically when other health problems such as chronic lung disease are involved.

Apparently healthy aged persons who do not complain about their sleep are almost as likely to be afflicted with impaired breathing during sleep. When heavy snoring and/or excessive daytime sleepiness are also present, a severe and immediate life-threatening problem may exist.

Large-scale studies that will conclusively document the incidence and prevalence of disturbed breathing during sleep in the elderly are badly needed. A great deal of work will be required to understand the health implications of the various subtypes of sleep apnea. It is crucially important to describe the natural history and progression of sleep apnea: on one hand, sleep apnea can be essentially a terminal illness threatening death during sleep on any night; on the other, it may be relatively benign in the absence of drugs (sleeping pills) that depress respiration.

Other very significant health problems are related to nocturnal breathing disorders. It has been clearly demonstrated that hemodynamic abnormalities and cardiac arrhythmias are frequently associated with sleep apnea syndromes. In addition, we now know that loud, sonorous snoring increases with age, and there is strong evidence linking the respiratory problems signaled by heavy snoring to the development of cardiovascular problems-- hypertension, stroke, and coronary artery disease. Thus, a generally overlooked sleep-related respiratory impairment could play a major role in those diseases most responsible for death and chronic disability among the elderly. Finally, although excellent surgical methods have been developed for treatment of upper airway sleep apnea, no effective treatment exists for central sleep apnea. Because the latter type appears also to be very common in the elderly, research on treatment is urgently needed.

B. 24-HOUR SLEEP STUDIES

Although many laboratory studies have examined the nocturnal sleep of the elderly, the findings have not been related to daytime function and sleepiness/alertness. Around-the-clock studies with emphasis on daytime alertness are badly needed to obtain a clear description of how greatly daytime sleepiness and fatigue undermine the quality of life in advancing years. Disturbed sleep at night is nearly universal in the elderly, and even today the full extent of this disturbance has not been described.

There is no evidence to support the notion that this age group needs less sleep than younger persons. Rather, light and interrupted sleep appears mostly to be due to specific sleep pathologies, and we assume that additional specific problems may yet be discovered.

C. SLEEPING PILL STUDIES

The complete lack of objective knowledge about the efficacy and safety of sleeping pills in the elderly must be immediately rectified. There must be thorough study of the effects of commonly prescribed sleeping pills on breathing and cardiac function during sleep in normal elderly subjects and in patients with all types and degrees of sleep- related respiratory impairment. A very serious danger may exist when elderly individuals take sleeping pills. In addition, the degree daytime sedation with long-acting hypnotics must be examined. It is likely that many elderly persons are completely incapacitated in the daytime as a result of sleeping pill use. Studies of cognitive functioning, psychomotor performance, and above all, daytime sleepiness/alertness, during chronic administration of hypnotics to the elderly are needed before final judgments on the relative safety and efficacy of these agents can be made

D. BIOLOGICAL RHYTHMS: CHRONOPATHOLOGY IN THE ELDERLY

A great deal of work is urgently needed in the area of biological rhythms. There have been no published studies on the sleep/wake function of elderly humans living in an isolated environment. Such studies will be important in determining whether endogenous oscillators function normally in individuals of advanced age. It has been suggested that people in modern societies may be chronically sleep deprived from adolescence onwards. Whether absolute sleep deprivation or suboptimal sleep schedules can contribute to long term impairment of the sleep/wake rhythm remains an open question. Nevertheless, nocturnal sleep studies should always be related to the subject's 24-hour schedule; and recordings are ideally performed throughout several consecutive days in the patient's usual

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environment using portable noninvasive monitors. Studies of 24-hour sleep/wake function and biological rhythms in institutions such as old-age homes and nursing homes deserve a high priority.

E. DIAGNOSIS AND TREATMENT OF SLEEP DISORDERS IN ELDERLY PATIENTS

Although a systematized classification of sleep disorders (based primarily upon the experience of experts treating younger patients) has recently been prepared, surprisingly little is known about the incidence, nature, and relevance of the panoply of such disorders in the aged. Furthermore, virtually nothing is known of the natural history of sleep disorders in individual patients. Sleep/wake disturbances associated with somatic and psychiatric illness deserve special attention. The availability of sleep disorders medicine to the elderly would be marvelously enhanced if Medicare coverage for elderly patients with disturbed sleep could be obtained.

F. THE NURSING HOME ENVIRONMENT

Many of the concerns mentioned earlier come together in the nursing home environment; the overuse of sleeping pills, the deleterious effect of bed rest on circadian rhythms, the interaction of chronic illness and sleep/wake functions to name a few. In addition, the nursing home has the potential for being the optimal situation in which to study biological rhythms and their disruption in the elderly, sleep disorders, and sleep/wake functions in general. These considerations logically indicate an urgent need to establish some type of resesearch and teaching or academic nursing home where new clinical concepts relating to sleep and wakefulness can be investigated and taught.

Many other legitimate areas of inquiry have been virtually ignored. We know very little about the prevalence in the general population of nocturnal gastrointestinal problems, palpitations, pain and discomfort, and other symptoms presumably common during sleep of the elderly. The sleep of physically sick or incapacitated elderly people has also rarely been investigated, despite the fact that insomnia is commonly cited as a symptom of many diseases afflicting the aged. Very little questionnaire or survey data are available concerning the effects of different environments on the sleep of the aged. Few studies have specifically addressed the effect of retirement upon sleep. Hormonal changes at the time of menopause are often cited as a temporary and presumably benign cause of sleep disturbances, but have not received careful study.

In summary, when the major concerns of elderly individuals are listed, sleep is always at or near the top. For this reason alone, sleep-wake studies deserve a heavy investment of resources and the attention and commitment of serious investigators. Future discoveries in the area promise to improve the quality of life for elderly men and women and to reduce the risk of dying during sleep, as well as providing further insight into the fundamental nature of sleep and the aging process itself. Benefits would include more rational and effective use of sleeping pills, more effective diagnosis and treatment of sleep disorders, and improved sleep hygiene and circadian function, with attendant increases in daytime alertness, energy, and zest.

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THE EEG IN WAKING AND SLEEPING ELDERLY PEOPLE AND THE RELATIONSHIP TO STATES OF CENTRAL NERVOUS SYSTEM DEGENERATION

A. EEG OF THE ELDERLY DURING WAKEFULNESS

Information concerning the EEG of the elderly during wakefulness has been accumulated by many workers (7, 17, 18, 19, 20, 21, 22, 23, 24, 30, 34). The consensus seems to be that in old age, diffuse slow wave activity (1-7 Hz) shows a progressive increase, and that this finding is associated with CNS deterioration and intellectual impairment. Focal slow wave activity occurs in 30-50% of normal elderly people, mostly in the left anterior temporal region, but is probably due to some localized vascular change, and there is no evidence that it is associated with functional impairment. Alpha waves decrease in amplitude, are fewer in number, slower in frequency, and have a different topographical distribution; and these changes may be related to decreased cerebral blood flow and chronic hypoxia. Beta activity does not change in frequency and may increase in amplitude and amount except in the very old (over 80 years) and very sick, when it may decrease. Beta activity may be related to mental arousal. Of special relevance are reports suggesting that the EEG of awake elderly people tends to be interrupted by brief episodes in which the EEG is consistent with that seen during sleep. Liberson termed these episodes "microsleeps" (16).

B. EEG IN THE ELDERLY DURING SLEEP

Several investigators have studied the sleep EEG of the elderly in similar detail. Smith and his colleagues (8, 14, 31, 32, 33) using automated EEG analyses, found that increasing age was accompanied by a decrease in the average amplitude of delta waves over 5 uV, slowing of delta frequencies, and a decrease in the incidence of delta waves greater than 20 uV. The incidence of delta waves greater than 5 uV remained constant across ages. Alpha (8- 12 Hz), beta (15- 34 Hz), and theta (3-7 Hz) waves were recorded during REM sleep. Unlike previous investigators, these workers found no age related changes in alpha frequency. They also found no changes in the average length, number of bursts, or overall duration of beta activity. Any changes in theta activity may have been obscured by the relatively restrictive definition of theta bursts. Sigma (11.75-16 Hz) sleep spindles (recorded during Stage 2 sleep) were not as well formed in the elderly, and the frequency increased slightly but had greater variance. The numbers of spindles were less than in the 25-34 year-olds, but similar to the numbers found in the 43-53 year-olds.

These findings were somewhat at variance with previous reports employing less sophisticated manual techniques (4, 5, 9, 11, 12, 25, 26, 27). In general, these workers found that delta waves, alpha waves, and sleep spindles all tended to show reduction in amplitude, number, and frequency of individual wave forms; and reductions in the duration of individual "bursts", the number of bursts, and total duration (expressed as overall percentage of the record). The EEG of REM sleep has been found to be more fragmented and invaded by slow waves. The focal or diffuse slow waves in the delta and theta frequencies seen in wakefulness in some elderly subjects, did not seem to be related to any changes in the slow waves of delta sleep.

Greenblatt (10) observed that such "normal" alterations largely account for the EEG differences found in certain neuropsychiatric conditions whose incidence varies with age. However, similar but more extreme changes occur in elderly patients with intellectual impairment, senile dementia, Alzheimer's disease, and other conditions collectively known as organic (or chronic) brain syndromes (1, 2, 3, 4, 5, 6, 25, 26, 27). This finding indicates that the altered EEG of sleeping normal aged people may well be due to CNS deterioration.

It must be noted, that all of these studies, including those of Smith and his colleagues, are qualified to some extent by the electrode placement, the stage of sleep in which the recording is made, the variable definition of the wave form categories, and whether or not the emphasis is on bursts of activity at that frequency.

EEG data has also been obtained from aging animals. It seems that compared with humans, the sleeping rat's EEG shows few signs of deterioration with age (28, 29, 35), and so it is of interest that neuronal populations in rats' cortex do not seem to decline with age in the same manner as in humans (15).

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